CONTENTS

FOR ENGINEERS AND CONTRACTORS CONTROLLING THE DESIGN, SPECIFICATION, INSTALLATION AND MAINTENANCE OF HEATING, VENTILATING AND AIR CONDITIONING.

HEATING & VENTILATING

AIR CONDITIONING

FOR FEBRUARY, 1940

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TOMORROW'S AIR CONDITIONING?

An indication of what the air conditioning system of tomorrow may look like is furnished by the system installed in a recently built home of an air conditioning engineer. This engineer, when planning his own home, developed his own air conditioning equipment. One unusual feature is that the system uses the same refrigerant for both cooling and heating. See page 15.

DUCT PRESSURES

The subject of duct pressures and their relationship with figured resistances has always been more or less hazy in most engineers' minds. Starting on page 19 is an article which correlates the mass of data which has been published from time to time with those necessary elements which helps make this data understandable.

FACTORY COSTS

Many persons have attempted to use the square foot as a unit for estimating the cost of industrial buildings. On page 23 there is an article which shows why such a unit can not be successfully applied unless a large number of variables are taken into consideration.

PROFITS IN AIR

Heading the Profits in Air section this month is an article which describes the modern steam and hot water heating system which is used by the Toledo Scale Company in its new factory in Toledo. In another article two experts of the New York Department of Labor outline the latest information on how to design exhaust systems for woodworking plants. Also included in this section is an article telling how Skilsaw, Inc., heats its new plant with forced hot water system.

JANUARY CONVENTIONS

A complete report on the five Chicago conventions and show, and the two Cleveland conventions and show, starts on page 43. For information on the new equipment presented at these shows see the section starting on page 67.

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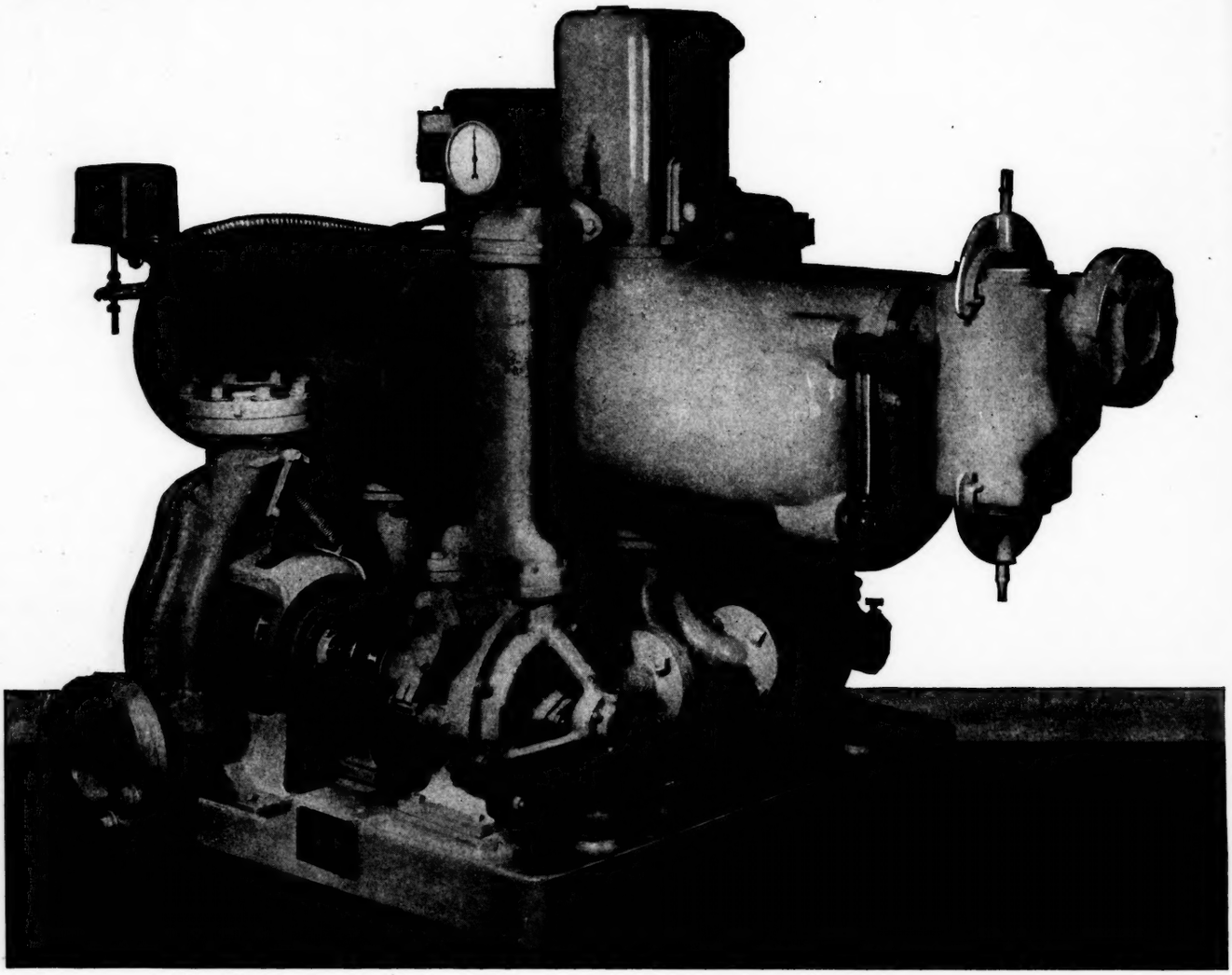
Where heat must *Not* fail . . . install this SAFE *Heating Pump*



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system. This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically by-passes from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure. The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

BULLETIN ON REQUEST

THE NASH ENGINEERING COMPANY

221-AS WILSON ROAD, SOUTH NORWALK, CONNECTICUT

Fig. 1. View of rear of the author's house for which he planned year-round air conditioning.

An Engineer Air Conditions His Home

By CARL F. BOESTER†

It isn't often that an engineer gets a chance to put his own ideas into equipment for his home to the extent to which the author was able to go. He developed both ideas and equipment of his own for the purpose and then, engineer-like, patented the distinctive features.

TO muster the courage to put in practice much of the theory (some of it from knowledge yet to be gained) about air conditioning that an engineer engaged in that field is bound to have, is indeed quite an experience, particularly when the engineer is his own guinea pig and year-round air conditions his own home.

The really tough decision is whether or not to *shoot the works* (compatible with cost and utility) and install a system embodying all the theories and ideas that the imagination can conjure up, or just to dabble with what seem to be new and better ways as indicated by the experiments of those engaged in laboratory research. The writer decided upon the former method.

It was evident that if a year-round conditioning system was to be installed that was low enough in first cost, it would have to be small in capacity. Equipment of limited capacity would not do the job unless the house were super-insulated. Such insulation calls for different and, therefore, in some ways more expensive construction. Where was the money to come from for this extra cost?

In assembling preliminary costs, it appeared that a basement had a cost far out of proportion to its usefulness. As a matter of fact, it cost much more than the amount required for insulating material and the extra cost of construction changes due to new insulating methods. Here was a chance to save a substantial sum, so the basement was crossed off and the house was placed on a sectional (to allow for expansion and contraction) concrete slab, rather thin, yet heavily reenforced. This slab was floated on a cinder fill of about 8 inches to allow for drainage under the house. The foundations for walls and interior wall footings were cast separately of concrete. The footings were put down some 30 inches to avoid frost heaving. The footings and slab were coated with pure hot pitch (not asphalt) to prevent moisture from coming through. On top of the pitch was laid a 1-inch thick insulating board made of licorice root, which grows under water and is therefore impervious to decay from moisture. It also has, I'm told, the quality of giving vermin acute indigestion.

Saving to Provide for Insulation

But I'm just a little ahead of my story. Money enough was saved on the basement for a good insulating job, including insulation of the air distributing duct work. The next question, equally important, was where was the extra money coming from to cover the cost of summer cooling equipment, which is over and above the cost of a boiler, conditioning unit and duct work for winter use. At this point my wife came to the rescue. We had, up to that time, been living in a hotel apartment that had no dining room, the living room serving as a combination living and dining room. Had we been inconvenienced? Not that we could remember. Why not eliminate the dining room from the new house? We figured that the cost of providing a separate room for a dining room not only furnished money for the cooling equipment but some toward an all electric kitchen, dishwasher, garbage grinder and all. Thus the money for the necessary extras was provided.

To go on with the engineering and construction features, the walls are of brick veneer construction—it

†Air Conditioning Engineer, St. Louis.

isn't cheap, either. One course of brick of white silica sand was used. This brick has insulating value. The small particles of white sand reflect a tremendous amount of radiated solar heat. The brick was tested for everything any other brick was supposed to do and passed all tests. A 1-inch air space was left between the brick and the sheeting material, an asphalt impregnated insulating board 1-inch thick. The stud and joist construction was of conventional design. 4 inches of glass wool was placed between the studs. An approved vapor barrier paper was then placed on the inside of the studs and the usual rock lathing followed with a good standard application of brown coat and finish coat plaster. This gives a perfectly insulated wall compatible with its cost, the heat transfer coefficient being 0.065 B.t.u.'s per hour per degree difference.

The house has all rooms on one floor, so 8 inches of glass wool insulation was used between the ceiling and the attic floor joists. Because we like lots of light and sunshine, and also the feeling of being close to the outdoors, the amount of window area in the house is large. With such well insulated walls, it became obvious that the windows should be conditioned. This meant one of the many versions of double glazing. Any way that we figured, it was going to cost extra. Well, since this was to be the perfect year-round air conditioned house, why should the windows be opened? For no reason at all. By using plain stationary sash and eliminating cords, weights, pulleys, locks, opening and closing hardware, the cost of the extra panel of glass was realized. The windows were so designed that the inner panel is removable for cleaning. What a boon to the housewife. No dust to blow in open windows or leaky window cracks. No more aching backs wiping dust from chair rungs. All the fresh air the Good Lord intended us to have is brought in through the cooling and heating system, filtered free of dust and pollen.

Metal Roof

After much thought, it was decided to use 26 gauge bonderized galvanized metal for roofing material. This would last until the house was ready to be razed by the tenth generation. The roof joists were sheeted with the same asphalt impregnated insulating board that sheeted the wall studding. The metal roof was then applied, using standing seam construction—no nails, screws or rivets in the whole roof—applied so well the strongest wind will never loosen it. In contracting work I have for some time used not only a rust preventing, but by actual experience a rust inhibiting paint, so I had the metal roof covered with one coat of such paint and then a coat of rich green. A white brick house with a green roof is certainly something for looks—character plus, I think.

What about Heating and Cooling

When we had *figured* the house to the roof stage, it was a question of what to put in for heating and cooling. Having been interested in several research projects on residential air-conditioning, this was indeed a problem. Which one of the many methods I had observed and tested should I use? Whose equipment to install?

I was lazy enough not to want to shovel coal or be annoyed by running out of oil. Good old dependable gas was the fuel I wanted, but that costs money. The idea, then, was to try to design a super-efficient plant that was to get every B.t.u. of heat energy out of the gas. Yes; I should also say that I had come to the conclusion some time ago that gas is the ideal energy for operating summer cooling equipment. Then why not build a unit entirely self-contained—one that would not only heat efficiently in winter but cool at low cost in summer? As you know, most systems for year-round conditioning are really two separate units and therefore costly. I had no such money. The system must be as silent as the burning of gas itself—no noisy starting and stopping; no moving parts to work loose and become noisy. Of equal importance, no moving parts to wear out and cause expensive maintenance, to say nothing of being without cooling on a hot night while waiting for the service repair man.

What are the requirements? One unit, two distinct functions, no moving parts—a real bill to fill. It is necessary to circulate the air and that requires a moving fan, but these are quiet and the only wearing parts are motor bearings, which oiled once a year should be

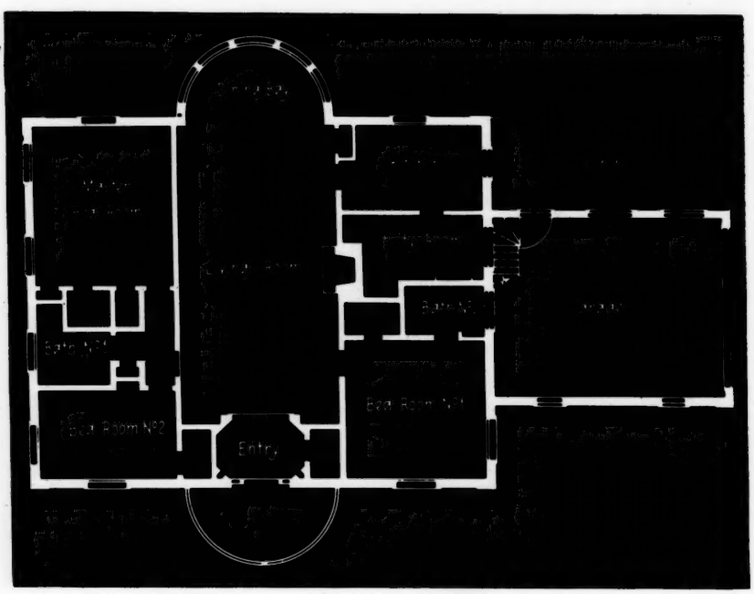


Fig. 2. Plan view of the Boester home. Note that all rooms are on one floor. No basement. Conditioning equipment is in attic and boiler is in utility room.

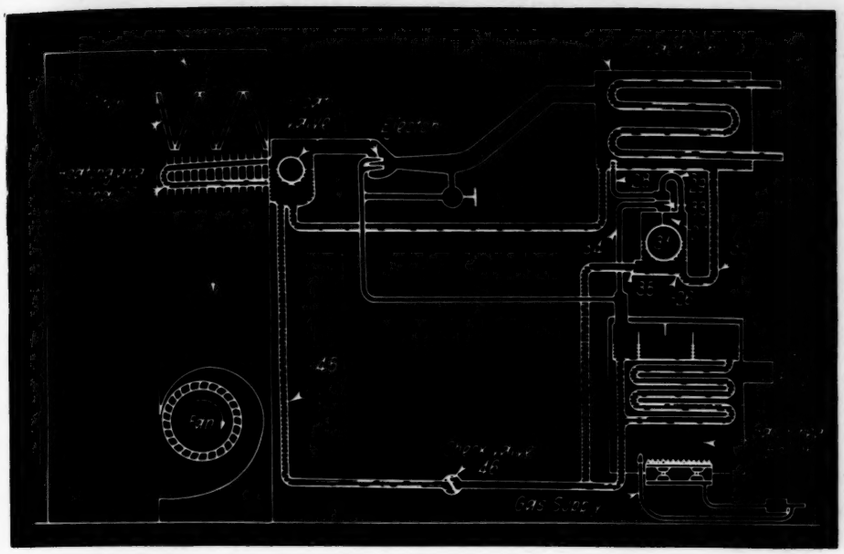


Fig. 3. Diagram showing the arrangement of the self-contained, gas-fired equipment which uses Freon vapor for both heating and cooling.

no source of trouble. Then, too, heat absorbed in the cooled interior of the house has to be rejected back to the outdoors as fast as it leaks in or is generated inside. This also requires a fan and equipment to reject such heat to the outdoors. So the only apparent moving parts were two small fans, one for a device built into the unit, known as an evaporative condenser, which rejects our summer heat. As you probably know, a summer cooling system is really only a heat pump, removing heat from the conditioned area at a rate equal to or faster than it comes into the space to be kept cool. There is no such thing as cold. Cold is heat lacking in intensity. So our cooling plant does not make cold; it simply pumps out heat.

Having settled on these requirements and having decided to do it differently, we thought we might as well be *whole hog* and use not only a new refrigerant for the summer cycle, but also use the same liquid refrigerant for winter heating. Water? No; it works for both summer and winter cycles but it is an old refrigerant and not terribly efficient thermally. Freon? Yes. Not Freon 12 but that new Freon 113. Freon 11 and 21 come close, but 113 is ideal—non-inflammable, non-toxic, handles like water, carry it around in a pail, it boils at 116 at atmospheric pressure.

For ease of explanation a flow diagram is shown as Fig. 3. On the left you see the conventional conditioning equipment. Nothing different. Filters, finned cooling coil and the usual fan. It has the same amount of coil surface as any system of equal capacity. The fan handles the same amount of air. The only difference is that this same coil serves as a winter heating surface. You will note that the refrigerant is admitted to the coil by a float valve instead of a thermal valve, but this too is old practice.

On the summer cycle as long as there is refrigerant in the coil and a vacuum is maintained on the coil by a compressor or some other device (an ejector in this case), the pressure over the refrigerant is lowered to a point where the heat of the air is able to boil the refrigerant and the refrigerant in so boiling absorbs the heat of the air. The heat laden refrigerant vapor is removed by the vacuum of the ejector shown on the sketch. To use the same coil for heating, high temperature Freon vapor is by-passed around the jet into the coil, surrendering its heat to the air and condensing to liquid Freon 113.

This brings us to the motive force or energy. To the right in the sketch is a gas fired boiler, in which we have liquid Freon 113. The gas boils the liquid into high pressure, high temperature vapor, which for ease of explanation we shall call Freon 113 steam. On the summer cycle this Freon steam is the motivating energy through the jets of the ejector. The steam, traveling at high velocity through the ejector jets, pulls a vacuum on the coil to which it is immediately connected. On the winter cycle this Freon steam is by-passed around the jet and condenses in the finned coil, heating the air passing over the coil. Thus the coil serves a dual purpose, which helps to lower first costs.

To continue with the summer cycle, the Freon steam passing through the ejector joins the lower pressure vapor from the coil, where the vapor is discharged into a shell and tube condenser. In the unit installed in my home an evaporative condenser is used. The refrigerant vapor is condensed in the usual and conventional manner.

The next step is to get some of the condensed Freon back to the coil and some back into the boiler, and in the exact quantities which both require. We don't want to use pumps for that makes for moving parts. Therefore, we place the condenser at the highest point in the system and allow the condensed Freon to return to the coil by gravity, the float valve admitting an amount of liquid Freon equal to that boiled away in the coil.

The rest of the Freon must be returned to the boiler from the low pressure side (the condenser) to the high pressure side (the boiler). Instead of a pump we use a boiler return trap or alternating receiver—another old friend and foolproof device used by heating engineers for years in getting water into a boiler against its pressure.

How Alternating Receiver Works

For those not familiar with its operation, the liquid Freon flows by gravity down pipe 30 through and past

check or non-return valve 26, filling receiver cylinder 27, any flash gas passing through pipes 29 and 28 to the condenser for recondensing. When the receiver is filled (a matter of seconds), float ball 31 raises piston 33 stopping the flow of flash gas through pipes 28 and 29. It simultaneously opens line 34, admitting Freon vapor from the boiler. The pressure in the receiver and the boiler is thus equalized and the liquid Freon in the receiver flows by gravity through non-return or check valve 35 down into the boiler, completing the transfer from low to high side of the liquid Freon. When the receiver is empty, the float snaps back to the original position, permitting more liquid from the condenser to flow into the receiver. The process is continuous during the cooling cycle. Thus the cycle is completed without moving parts to wear out or become noisy.

To complete the story, the condenser is shut off on the heating cycle and the Freon steam condenses in the coil, where it returns to the boiler by gravity through pipe 45, past check valve 46. Gas thus becomes the source of power for summer cooling as well as winter heating. The same device, entirely self-contained, accomplishes all the functions of winter and summer air conditioning.

For humidifying, a humidifier nozzle is placed in the air stream, and the water controlled by a solenoid valve operated by a humidistat wired in series with a windowstat to prevent moisture condensation on the windows. With double glazed windows this chance is remote; nevertheless the safety of a windowstat is desirable.

Controls

The controls for the system are complicated, but need not be. In order to thoroughly test many magnet valves and relays, the system is so hooked up that if it is chilly in the morning, the heat will automatically be turned on; if by noon it has warmed up enough to require cooling (seldom possible, of course), the controls would shut off the heat and start the cooling. If by late afternoon the outside temperature were just like a spring day, the system would be entirely cut off except for air circulation and fresh air supply. Fresh air is injected into the conditioning system by a separate fan for this purpose alone.

The summer cycle is controlled by a device which is a thermostat with a humidistat integrally hooked up with it to reset the dry bulb response as humidity affects conditions. This is set to maintain a 76-degree effective temperature. The winter cycle is controlled by a similar device except that it has a heat anticipator coil to increase the frequency of *on* periods and prevent too wide a temperature swing. This is set to maintain a 70-degree effective temperature.

You may have guessed that there have been many headaches in working out this system. To name a few: (1) the design of an ejector for Freon 113 steam; (2) the design of a transfer device that is foolproof and efficient; (3) the fact that Freon 113 will go through most kinds of piping and through any casting; hence, a loss of charge; (4) the fact that the makers of Freon 113 have not as yet tables available for this refrigerant, thus making the design of the condenser as a whole a great problem. Nevertheless, all of the problems were solved, and suitable patent rights procured or applied for, and some day this system may be generally accepted. Having experienced all these headaches, the writer has developed a number of ideas on simpler ways to do this job.

Other Features of Plant

To continue with some of the other perhaps *hair-brained* ideas which we built into *Today's House of Tomorrow,* the writer wanted personal experience with radiant heating and cooling, so auxiliary equipment was installed to be hooked up to panels in the walls of some rooms and the floors of the two bathrooms. For emergency, a steel fireplace having a B.t.u. capacity to heat the entire house was installed, the warm air from this unit being discharged by a special fan into the main conditioning unit for distribution to all the rooms of the house. This fireplace fan is controlled by a separate thermostat in the fireplace flue, so that when a fire is built it automatically starts this fan, injecting the heated air into the conditioner for distribution. When the fire dies out, the fan stops, without the attention of a forgetful owner. When a fire is built simply for looks or pleasure, the heat is automatically used in the system, thereby saving gas. The hot water for domestic use, as well as that distributed through the radiant panels, is obtained from a flue gas heat recoverer, making this energy free. It is a great comfort to step from a shower to a warm bathroom floor, the radiant panels being about 105F and the floors about 90F.

Fresh air for ventilating purposes, sufficient to keep down odors and provide oxygen, is brought in by a special fan, as mentioned. Most of this is exhausted through the fireplace flue, but there are also exhaust flues in the kitchen and baths. The kitchen exhaust fan is controlled by a switch near the stove and used when cooking odors are present. In the baths the problem is somewhat different, and therefore the bathroom exhaust fans are on three-minute time switches, which automatically stop themselves when the desired ventilation is completed.

The conditioned air, both summer and winter, is distributed through outlets placed in the center of room ceilings, and results are perfect. Return air passes through grills in the baseboards connected to wall stacks returning overhead to the conditioning equipment which is in the attic space. In this installation the Freon boiler is on the ground floor in the utility room.

The house has the newest in lighting practice and we believe has every known electrical gadget, including a garage door opened by a radio impulse from a device on the owner's car, for, after thinking up all these ideas, he is too tired to get out of his car and open the doors himself.

The whole thing has been a lot of fun. The ideas have worked. A record of performance is now being kept. We predict that residential air-conditioning has a real future, but its development has only been started. Much is yet to be learned, but we enjoy learning.

Duct Pressures

Their Correct Interpretation

The writer, in the course of his actual air design work, has noticed for some years the evasiveness with which the subject of duct pressures and their relationship with figured resistances has been treated. So few engineers in air design work seem aware of the correct considerations surrounding this subject that the writer has been prompted to write this paper with the hope of correlating the mass of data which has been published from time to time with those necessary but elusive elements which would make this data thoroughly understandable.

By F. F. KRAVATH†

THE study of pneumatic flow is very similar to that of hydraulic flow, a fact which has been recognized for many years, and for that reason experience which has been gained in one field has been freely used in the other, and rightly so. Yet, while a principle may be true for both fields, its practical application may differ so widely as to make it appear that the principle itself does not hold for both. In the study of hydraulic flow in pipes, and the various elements affecting the pressures therein, it is found that the pressure corresponding to the pipe velocity, or the velocity head, is usually so low (by virtue of the comparatively low pipe velocities used in hydraulic flow) that it may virtually be disregarded when figuring the total head against which flow must be maintained. In pneumatic flow, especially in the fields of Dust Control, Pneumatic Conveying, Air Conditioning, Heating and Ventilating, and Drying this same condition does not exist. The velocity pressure corresponding to the pipe velocity is usually a fair percentage of the total head worked against and as such cannot be disregarded without risking poor performance, uneconomical operation, or some combination of both. Whether this is disregarded under the misapprehension previously stated or whether misinterpretation of the fundamental elements dealt with is responsible, it is a fact that much confusion exists regarding this important phase of air design, especially as regards the calculation of system resistances and their correlation with published data by manufacturers on fan performance. This article will re-define all the necessary elements, show their inter-relation, their correlation with published data, the most accurate way of figuring each, the effect of *good enough* figuring, and the possible savings to be realized as a result of correctly understanding and applying this information.

Static, Velocity, and Total Pressures

Static pressure is the compressive pressure existing in a fluid and is a measure of its potential energy. It may exist in a fluid in motion or at rest. In an exhausting system, the compressive pressure is negative indicating a rarefaction within the duct which is greatest at the fan impeller and a minimum at the most remote air inlet. The differential head of the atmospheric pressure causes air to flow into the partially rarefied space at the air inlet. It is always measured with a manometer gauge or differential tube inserted into the duct at right angles to the direction of flow, indicating whether there is a negative or positive differential with the atmosphere and the degree of such differential. See Fig. 1.

Velocity pressure is the pressure corresponding to the velocity of flow and is a measure of the kinetic energy of the fluid. It is always positive and exists whether flow is confined in a duct or is in free circulation. In order to measure velocity pressure, it must be isolated from the compression or suction pressure within the duct, which is best done by the Pitot Tube, or as shown in Fig. 1.

Total pressure is the sum of the static and velocity pressures and is a measure of the total energy existing in the fluid. Since, in fan work, some of the pressures measured frequently are negative, confusion may be avoided by amending the foregoing definition to read that the absolute total pressure is the sum of the absolute static pressure and the velocity pressure. Thus, if the atmospheric pressure corresponding to 29.92 inches of mercury is 407 inches of water and the static pressure as measured was — 3 inches of water, with the velocity pressure 1.5 inches, then the absolute static pressure will be $407 - 3 = 404$ inches of water and the absolute total pressure $404 + 1.5 = 405.5$ inches of water. The total pressure, of course, is then $405.5 - 407 = -1.5$ inches of water.

The three aforementioned pressures are fundamental and, as such, should be used to the exclusion of all other terms meaning or purporting to mean the same thing. However, for various reasons such terms as *resistance pressure* and *impact pressure* have come into use as has the substitution of the symbols $+ RP$ and $- TP$ for the static pressure, respectively, of a blowing and an exhausting system. By resistance pressure is meant the pressure necessary to overcome the resistance to air flow from the air inlet to the point of measurement in a duct under suction, and from the point of measurement to the air outlet in a duct under pressure. The former, it has been explained in published data, may be

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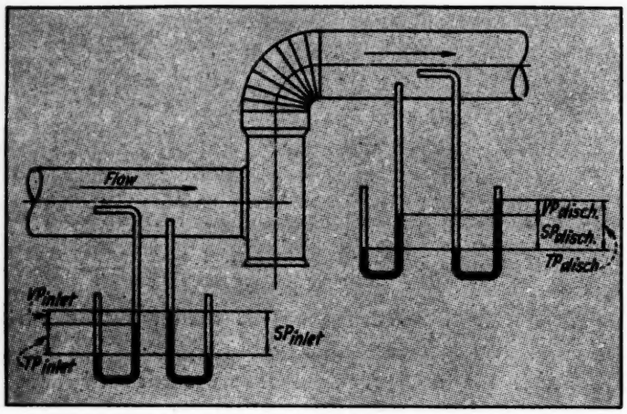

Fig. 1. Method of measuring Total, Static and Velocity Pressures.

obtained by the use of an impact tube, which makes it exactly equal to what we have called the total pressure (on the inlet side), while the latter, also called $+RP$, is supposed to be exactly equal to what we have called the static pressure (on the outlet side). It is with the latter statement that the writer takes issue, since it is true only where the blowing duct is of constant diameter, or cross-section. Where the discharge pipe is of varying section, whether contracting or expanding, the statement does not apply since static pressure is being converted into velocity pressure in the first case, and velocity pressure into static pressure in the second. To say that regardless of the conversion of potential to kinetic energy or vice versa that the static pressure wherever measured on a blowing pipe represented the resistance at that point would be tantamount to saying that an expanding section offers less resistance to the flow of air than a straight section of the same diameter as the large end of the expander and of the same length — obviously untrue, or that a reducer offers more resistance to the flow of air than a similar length of pipe of the same diameter as the small end of the reducer— also untrue.

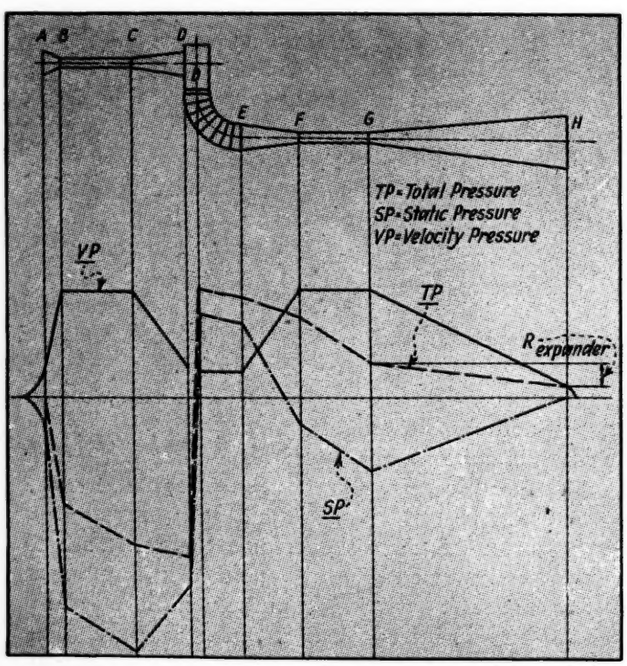

Fig. 2. Illustrating effects of change of section on TP, SP and VP.

Referring to Fig. 2, here is shown a graphic representation of the static, velocity, and total pressures existing at every point in a sample duct system with both inlet and discharge pipes of varying section. It is to be noted that the static pressure close to the face of the air inlet or hood is not zero, as might be supposed but is exactly equal and opposite in direction to the velocity pressure corresponding to the velocity at the face of the hood. The total pressure being the sum of the static and velocity pressures is, of course, zero up to the entrance of the hood, inasmuch as no resistance has been encountered to the flow of air outside of the hood. In going from *A* to *B* there is encountered some hood resistance and at *B*, the throat of the hood, the vena contracta occurs (actually a small distance behind *B*) adding more resistance. The resistance, always a function of the air velocity at the point of measurement is exactly equal thus far to the total pressure. The velocity pressure increasing from *A* to *B*, is constant from *B* to *C*, and decreases from *C* to *D* at the fan inlet through an expander. Returning again to the total pressure curve, we note an increase from *B* to *C* through the straight section, and a slight increase again through the expanding section, indicating that this section does cause a slight resistance loss. Turning to our static pressure curve, we note that it is at all times equal to the algebraic difference between the total and velocity pressures or is numerically equal to the sum of the total resistance encountered up to any point plus the velocity pressure at that point. Going from *C* to *D* on this curve, we note a drop in the graphic value but an increase in the actual value of the static pressure, indicating a conversion of kinetic or velocity energy into potential or static energy. It is to be noted that the increase in the static pressure value does not equal the decrease in the velocity pressure value, indicating less than perfect conversion or a slight shock or resistance loss within the expander. This loss is, of course, represented on the total pressure curve as a slight increase. With 100% efficient conversion, the *TP* curve from *C* to *D* would be perfectly horizontal, indicating no loss. Referring now to the outlet of the sample system, somewhat beyond *H* it can be noticed that a small total pressure exists which is exactly equal in magnitude to the velocity pressure at this point, the static pressure being zero. Proof that the static pressure at *H* is zero is apparent from the fact that air discharging from any stack always carries a fair distance before piling up in the relatively still atmosphere. Existence of a positive pressure, no matter how small, would cause an instant spreading in all directions. This is exactly true in the opposite sense at the inlet to the system where a short distance in front of the hood a small negative static pressure exists and where a very pronounced gathering in of air occurs. Going backwards, now, from *H* to the fan discharge, it is noticed the velocity pressure increases from *H* to *G*, stays the same from *G* to *F*, decreases from *F* to *E*, and remains the same from *E* to *D*. The static pressure curve shows a decrease from *H* to *G* going from atmospheric to a negative

value. This does not mean that the expanding section shown has no resistance, it means that the resistance of the piece is somewhat less than the actual conversion from kinetic to potential energy. The actual resistance of the expanding section is shown on the total pressure curve as the difference in the curve levels at *G* and *H*, labeled *R* expander. Going from *G* to *F* through the constant section, both the static and total pressure curves show an increase equal to the actual resistance in the section. From *F* to *E*, through the reducer, the total pressure curve registers an increase equal to the actual resistance of this piece, while the static pressure curve shows an increase equal to the sum of the resistance of this section plus the conversion of energies. From *E* to *D*, through the constant section, both the static and total pressure curves increase an amount equal to the resistance of this section.

It is extremely difficult to follow an explanation of this order, especially as refers to the blowing side of the system, without the danger of confusion. First, it must be realized that flow goes from the fan discharge to the system outlet and not vice versa as our explanation progressed. Description was made in this order to bring out some of the fine points existing at the fan outlet more effectively.

What, then, you may ask, is the benefit of such a chart. If it does nothing else, it brings out the fact that the total pressure curve is the curve we are really talking about when we speak of resistance pressure. In other words the total head we have to work against in any system is the sum of the loss at entrance to the system, every individual resistance and shock loss throughout the system, plus the velocity head at the discharge of the system—which is the total pressure the fan will have to develop. What then, is the value of figuring static pressures? In any system, the volume of air flowing through any inlet is equal to the following:

$$Q = 4000\ A\ C\ \sqrt{SP}$$

where Q = volume of air flowing through the inlet in c.f.m.
A = area of throat of inlet
C = the restriction coefficient
SP = static pressure existing at the throat of the inlet in inches of water

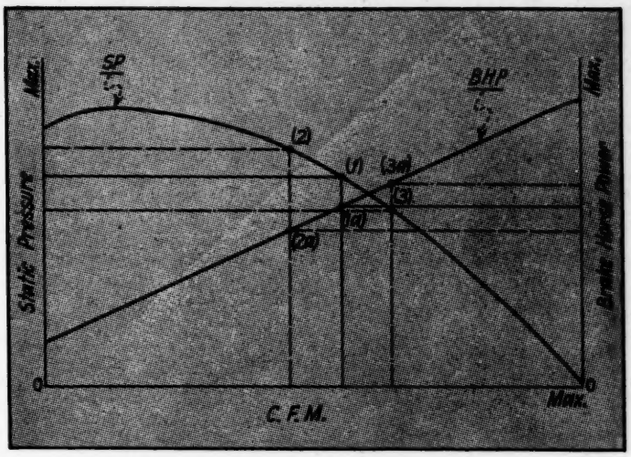

Fig. 3. Fan performance curves at constant R.P.M. and effects of incorrectly figuring static pressure.

It is important to note that in balancing up a system of many outlets and branches to give the desired air flow in each branch that it is the static pressures in each branch which must be balanced and not pure resistances.

Another interesting point disclosed by this chart is the situation at *G* where the Venturi effect is gotten so that if, for some reason, it were desired to make connection to this system at *G*, air would flow inwards. (This principle is made use of in the Venturi Ejector used to handle corrosive fumes without carrying them through the fan.) Another interesting point, gotten from the total pressure curve, shows that regardless of the shape of the duct — straight, expanding, reducing, whether of large or small diameter or length—every section of every duct offers some resistance to the flow of air.

Due to the fact that most fan manufacturers list their performance data under a term called *Fan Static Pressure* or ^{SP}fan, it is necessary that we understand what this term means in terms of our measurements and our calculations. Examining the following derivation—

by definition of the fan manufacturers

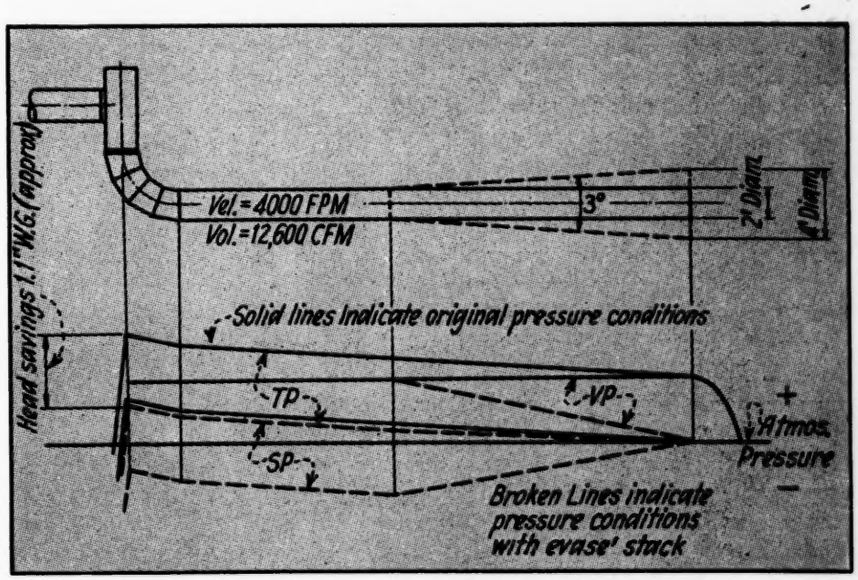

Fig. 4. Effect of replacing section of discharge stack with evasé.

$$^{TP}\text{fan} = {}^{TP}\text{fan inlet} + {}^{TP}\text{fan discharge} \quad (1)$$

$$\text{also } {}^{TP}\text{fan} = {}^{SP}\text{fan} + {}^{VP}\text{fan} \quad (2)$$

$$\text{also } {}^{VP}\text{fan} = {}^{VP}\text{fan discharge} \quad (3)$$

$$\text{hence } {}^{TP}\text{fan} = {}^{SP}\text{fan} + {}^{VP}\text{fan discharge} \quad (4)$$

$$\text{or } {}^{SP}\text{fan} = {}^{TP}\text{fan} - {}^{VP}\text{fan discharge} \quad (5)$$

$$\text{also } {}^{SP}\text{fan} = {}^{TP}\text{fan inlet} + {}^{TP}\text{fan discharge} - {}^{VP}\text{fan discharge} \quad (6)$$

$$\text{or } {}^{SP}\text{fan} = \left\{\begin{array}{c}\text{Sum of all resistances on inlet}\\ \text{side of fan}\end{array}\right\} + \left\{\begin{array}{c}\text{Sum of all resistances}\\ \text{on discharge side}\\ \text{of fan}\end{array} + \begin{array}{c}\text{Velocity pressure at}\\ \text{final outlet to at-}\\ \text{mosphere}\end{array}\right\} - {}^{VP}\text{fan discharge} \quad (7)$$

It is extremely important that equation (7) be thoroughly understood and remembered. While it may also be stated that $^{SP}\text{fan} = {}^{TP}\text{fan inlet} + {}^{SP}\text{fan discharge}$, it is preferable to remember the equation as stated in (6) and (7). At no time should the static pressure at the fan inlet be added to the static pressure at the fan outlet and this result be called static pressure of the fan. At least one fan manufacturer lists performance tables for fans under columns labeled C.S.P. This term meaning combined suction and pressure or the sum of the static pressure at fan inlet plus the static pressure at fan discharge, is equal to the total pressure of the fan where the fan inlet and discharge are of the same cross-sectional area and usually a fan listed thus will be.

What, then, would be the result of improperly figuring air systems whether as a result of insufficient knowledge or error? It is very possible that one might be in luck and, by a combination of errors which balance each other out, good performance might result. On the other hand, the errors might be cumulative and poor performance would result. If, in figuring, more resistance were allowed for than was actually present to be overcome, there is an excellent possibility that the fan, in hogging more air, would overload the motor; at any rate, more air would be handled than had been originally figured and the result would be uneconomical operation, and, depending on the job to be done, perhaps even poor performance (where too much air is undesirable). If less resistance were allowed than was actually present, the fan would find a new operating point on its pressure-volume curve and would handle less air than had been figured on, resulting in poor performance. Referring to Fig. 3, here is shown the effects of both types of errors. Operating point (1) represents the figured SP and c.f.m. which, for the purposes of this example, are assumed to be incorrect. (2) is a sample operating point where the actual SP exceeds the figured, while (3) is a sample operating point where the actual SP is less than the figured. It is readily seen from the curves that at (2) a decrease from the figured amount of airflow will result, while at (3) with an increase over the figured amount of airflow, an increase in required BHP also results with the danger of overloading the motor. A curve such as shown on Fig. 3 would apply very closely to a planing mill exhauster or straight bladed fan. With a backward curved blade fan or non-overloading type fan, the effects as illustrated are somewhat minimized, while with a forward curved blade fan, the effects shown are exaggerated somewhat. Demonstrating, now, the practical benefits of a good understanding of duct pressures and their correct interpretation is the following example, exaggerated slightly for illustrative purposes—and featuring the evase stack (Fig. 4).

Referring to the pressure graph, the solid lines indicate the pressures throughout the discharge stack corresponding to VP, SP, and TP. The broken lines indicate the pressures throughout the stack as a result of the substitution of a 3° evase stack of outlet diameter equal to twice (in this case) the inlet diameter, for a straight length of pipe of constant diameter and similar length. The net saving in head is made up of the reduced friction in the section itself plus the actual conversion of kinetic to potential energy or velocity to static pressure. As a result of this change, a drop in total pressure of approximately 1.1 inches water gauge results, with the following saving in horsepower and cost of operation—

$$\text{Hp. saving} = \frac{\text{Head saving (in inches W.G.)} \times \text{c.f.m. flowing}}{6356 \times \text{Fan mechanical efficiency}} = \frac{1.1}{6356} \times \frac{12{,}600}{.60} = 3.74$$

Considering a plant working 8 hours a day for 250 days a year and whose cost per kw.-hr. is $.02—

Operating saving per year

$$= 8 \times 250 \times .02 \times 3.74 \times .746$$
$$= \$112.00$$

This saving is for a relatively small system. One can readily imagine the savings possible with a great number of systems, many of them large, and many operating for longer periods than the 8 hours per day taken in this example.

While it was attempted in this article to bring out some of the fine points so vital to a thorough understanding of duct pressures and their correct interpretation, it was not intended to cause any confusion or to fly in the face of any accepted tradition such as seems to exist with reference to the interchangeability of the terms *fan static pressure* and *resistance pressure*. While it is the writer's firm opinion that we would be far better off without the use of the latter term, as was explained in the body of the article, if it will be remembered that wherever a change in cross-sectional area of the duct occurs it is necessary to take account of the conversion of potential energy into kinetic or vice versa, and that this will affect the *resistance pressure* as it affects the static pressure, the writer will have considered his labors well spent.

The Fallacy of the Square Foot as a Unit for Factory Costs

By CHAS. A. HAYNES†

SPECIALISTS in industrial building design and construction are continually being asked the square foot costs of industrial buildings—sometimes in terms of total area, but more often for a building of a specific size, for example, 200 x 800 ft. This question cannot be satisfactorily answered without first making a survey of general conditions. Accumulated cost data on practically every type of industrial building in various localities indicate that there is no definite answer to such a request particularly unless the general plant requirements are known. Square foot cost curves, based on specific territories and similar types of building have been developed but these are not accurate due to such variables as codes and owners' requirements. It is difficult even for specialists to apply such curves intelligently; they would be extremely dangerous in the hands of the layman.

The heating and air conditioning engineer readily appreciates that the first cost of a heating plant for a building in relatively warm Atlanta is sharply different from the cost of a plant for the identical building in Minneapolis; that an air conditioning system for a plant in the hot dry climate of Kansas City is wholly different from one in moist and not so hot New York. This difference in geographic location can and does make a great difference in the first cost of the heating, ventilating or conditioning system. The type of the product manufactured, and even the specific department concerned, also affects this phase of the total cost of an industrial plant.

What may not be so well realized are the effects of other variables on other components of industrial building costs. The following summary of a few of these items is presented to show how the square foot price of similar buildings of the same area may differ.

Location of Site—The nature of the soil, the amount of excavation or grading, and the type of foundation work required play an important part in plant design. Some buildings require only simple foundations, while in other cases, because of low bearing capacity of soil and heavy machine foundation requirements, the substructure work costs as much as the building itself. Again the shape of the site determines the type of building to be erected, and may limit the methods of future expansion. Proximity of the site to railroads and roadways can affect construction costs to an important degree, as can the distance to public utility services.

Type of Product Manufactured — Each industry, such as chemical, steel, textile, machine parts, rubber, and so on requires a different type of construction materials, ventilation, floor finish, column spacing, building height, etc., all of which have a decided influence on the cost of the plant.

Type of Personnel—Industrial operations and different localities have a bearing on the type of personnel employed. In many states and under some industrial codes specialized facilities are demanded for the women operators. This not only necessitates an increase in floor area to provide the various rooms, but a duplication of plumbing, lockers, and general service equipment.

Types of Building Construction—Even in similar industries, for reasons of irregularities in site, financial limitations and local conditions, different types of buildings may be desirable, thus affecting the final cost.

Mechanical Services—Heating and air conditioning have already been mentioned. Other services which affect cost include lighting. Warehouse space, for example, generally requires a minimum of electric lighting, while for manufacturing areas high intensity fluorescent lighting may be more suitable. Thus costs may vary from 12 to 40 cents per sq. ft. on the electrical work alone.

Plumbing requirements naturally change with the type of personnel employed, the shape and size of building and the exterior location of sewers and water supply.

Exterior Services—Consideration must be given to whether services will be purchased from utility companies, or whether a power house is constructed in connection with the proposed plant. Location and number of roadways required for trucking and personnel use, and the need for railroad sidings and loading equipment must be considered in the cost.

Insurance companies' requirements for fire and property protection may necessitate the building of outside water tanks, water lines for hydrants, fences surrounding the plant, watchmen's houses, and in some cases flood lighting for night protection. These, when added to the cost of parking facilities, landscaping and other general utilities, often run into large sums of money.

The preceding brief and by no means comprehensive illustrations reveal the impossibility of making snap judgments on the estimated cost of any type of building, and emphasize the need for an individual detailed preliminary review of actual requirements for each building before any appropriation is requested. National or sectional building average price fluctuations on a percentage basis can be obtained from several of the curves developed by the Government and other sources, but these should be detail checked against local conditions before any revaluation of plants is made or comparison is made between existing and proposed plants.

†Office of Albert Kahn, Inc., Detroit.

When a Contractor Loses Customer's Goods

By CHARLES R. ROSENBERG, Jr.†

AN air conditioning dealer's shop would make a splendid setting for a thrilling and dramatic motion picture. For instance:

In the opening scene a customer turns over to the dealer a burner or other piece of equipment for repair or replacement of parts. The dealer is all smiles. The job is not so important or profitable in itself, but these service items keep customers in contact with the shop. Presently, however, things begin to happen. The customer's burner is stolen from the shop. Or perhaps it simply disappears and nobody knows how or why or when. Or, again, the burner may have been destroyed or damaged by fire.

Just what happens to the customer's goods thus left in the dealer's shop may depend pretty much upon the caprice of fate, but whatever the cause of loss or damage to the customer's article, the contractor is sure to be cast for the role of villain. The lost item, so the customer says, was a very valuable one, it was practically new, and the customer left it in the dealer's care only because he had the greatest confidence in him. Now it's time for the dealer to make good the loss.

The moment the dealer takes his customer's goods into his possession for repair, for replacement of parts, or even for storage, he becomes at once a party to a transaction known in the law as a bailment. Technically, a bailment is a contract whereby one person delivers an item of personal property to another person for a particular purpose and on the understanding that the article is to be returned to its owner when that purpose has been accomplished. Thus a customer delivers an item that he owns, to the dealer for the purpose of having the dealer repair it or put in certain replacement parts. When the repairs or replacements have been completed, the dealer is to return the article to his customer upon being paid for his work and parts.

Now the type of bailment represented by such a transaction for repairs or replacements is sometimes called a "mutual benefit bailment." This is because both parties to the transaction derive a benefit from it. The customer gets his article repaired and put in good working order, and the dealer receives compensation.

In such a bailment for repairs or replacements the dealer is said to be obligated to give his customer's goods "ordinary care." This means the same care that a reasonably prudent man would give his own goods. As far as liability for the loss or destruction of a customer's article is concerned, he is responsible for what the law calls "ordinary negligence." In short, he is financially and legally liable to the customer if the article is lost or destroyed through the dealer's *failure* to give it "ordinary care."

†Attorney-at-Law, Media, Pa.

When a customer's goods are lost or destroyed while in a dealer's hands, the customer is quick to claim that the dealer is absolutely liable for the full value of the goods. At law the dealer is not responsible at all unless the loss or damage was the result of the dealer's failure to exercise the "ordinary care" required of him.

If the customer's item was stolen, for example, the dealer is not responsible for the loss unless he failed to take ordinary precautions to protect the article from theft—such as by locking up the shop at closing time and perhaps locking the customer's goods in a separate room. Certainly if he took reasonable precautions to prevent theft, the dealer is not responsible if a thief breaks into his place and steals the customer's goods. The dealer does not insure the customer's goods against every thief who walks the streets. If the customer's article is stolen by the dealer's employe, however, the law will hold the contractor responsible.

Similarly, if the customer's goods are destroyed by fire while in the dealer's custody, the dealer is not responsible for the loss unless he was in some way to blame for the fire. If he was careless in leaving inflammable materials about or in some other way contributed to the fire hazard, the law might well say that this was a lack of the "ordinary care" which he owed to his customer in the protection of the latter's goods, and in such case the dealer would have to pay for the loss. If, however, the fire was not the result of any carelessness on the part of the dealer, the law will not hold him responsible to pay for the customer's goods.

The heating and ventilating dealer or contractor has the law definitely against him in one respect when a customer's goods are lost or damaged while in his custody. From the very fact that the goods have been destroyed or damaged, the law "presumes" that it was the dealer's fault. The burden is then on the dealer to overcome this legal "presumption" by proving that the damage was not the result of any lack of care on his part but was due to conditions beyond his control. This legal presumption against the contractor is very disastrous when customers' goods have been lost or damaged, and the dealer is unable to give any satisfactory explanation as to how it happened.

What happens if your customer's property is stolen?

Where a dealer takes in a repair job and "farms it out" to another organization, he will be held responsible if the outside organization loses or damages the article. The legal theory is that the customer entrusts the article to the dealer and not to some outside party. If the dealer decides to turn the job over to someone else, he takes the risk of any loss or damage occurring while the item is out of his personal possession.

A SECTION OF "HEATING & VENTILATING" SHOWING
INDUSTRIAL PLANTS PROMOTE PRODUCTION
BY SCIENTIFIC CONTROL OF

TOLEDO SCALE COMPANY

heats its new factory in Toledo with projection type steam unit heaters. Forced hot water provided for office portion to avoid visible or underground returns.

By G. S. WHITTAKER†

THE Toledo Scale Company, a nationally-known organization, during its period of growth has had many parts manufactured in separate buildings which have been purchased or built as sales increased. These separate units have been, in many cases, located in different parts of the city, and even in other towns.

Centralization of these units has been considered desirable in that it would bring about central control of inspection and production, improve operating efficiency, and would further employee personnel relations.

When the new central plant was decided on, Toledo was fixed as the location for the first unit to be constructed. At this unit, here described, parts will be manufactured and the scales assembled. It is so located that expansion can take place either to the north or south, and the main heating supply and return lines have been designed to take care of this future expansion. Provisions for material handling, the boiler house, and inflammable storage space, are located on the west side of the building and can be augumented in any direction and to any size without interfering with the main manufacturing building.

The main structure is 420 ft. wide x 440 ft. long, comprising a large one-story factory space and a two-story 240 ft. x 64 ft. portion in the front for administration offices.

To provide for immediate requirements the administration offices consist of approximately 31,000 sq. ft. of floor space, embodied in the main building as a self-contained unit. This permits of expansion at any time in the future, by additional stories, without interfering with the daylighting or operation of the manufacturing unit.

†Office of Albert Kahn, Inc., Detroit.

Manufacturing Unit

Since many of the manufacturing departments are self-contained, and because of the continual improvement in manufacturing methods and types of materials used, it was necessary to consider a manufacturing area which would be adaptable to any type of changing conditions, and with sufficient uniform daylight in any part of the building. Several different types of roof construction and column spacing were designed to allow for these conditions, and finally 60 x 40 ft. was found to be the most economical and at the same time provide for any possible unforeseen manufacturing conditions that might arise.

It was found necessary that certain departments be enclosed to take care of particular manufacturing requirements. With this condition necessary, 100% vision and removable type partitions were designed from steel factory glazed sash window units, so connected that they may be easily removed, replaced or extended as the occasions arise.

While the complete exterior of the building is daylighted with glazed steel windows, the roof monitors have been so designed as to allow for uniform light of

correct working intensity in every part of this building, which is 400 ft. at its narrowest point. This development of the correct locating of the widths and heights of the monitor windows is based on actual results obtained from many similar plants located in different parts of the country.

No provision for air conditioning has been made, but considerable thought was given to the ventilation of this building. The design allows for the entrance and movement of air to be taken care of by ventilation located in the lower portions of the sidewall sash, and discharged through window ventilators placed in the monitor sash. These ventilators are so grouped that different air movements may be controlled in any part of the building.

Boiler House

To provide for the several heating requirements a boiler plant (serviced by a railroad siding) has been located near the main building in such a position that it will not only take care of present requirements but may be extended as the plant grows. Steam is generated in two boilers at 100 lb. pressure. The boilers are fired by stokers. A small percentage of the steam generated is used for process purposes in the factory at full boiler pressure, so that high pressure steam is necessary.

Piping

The steam leaves the boiler house in an 8-in. steam line which runs underground in conduit to the factory and, after a branch leading to the process machines is taken off, the main leads to a pressure reducing valve where the steam is reduced to 30 lb. pressure. From

THIS INSTALLATION

Plant — Toledo Scale Co.

Location — Toledo, Ohio

Architects & Engineers — Albert Kahn, Inc., Detroit

Heating & Ventilating Contractor — A. Bentley & Sons

Fig. 1. The new Toledo Scale Company plant. The Administration portion of the building is in the foreground with the factory to the rear. Back of the factory, the boiler house stack can be seen.

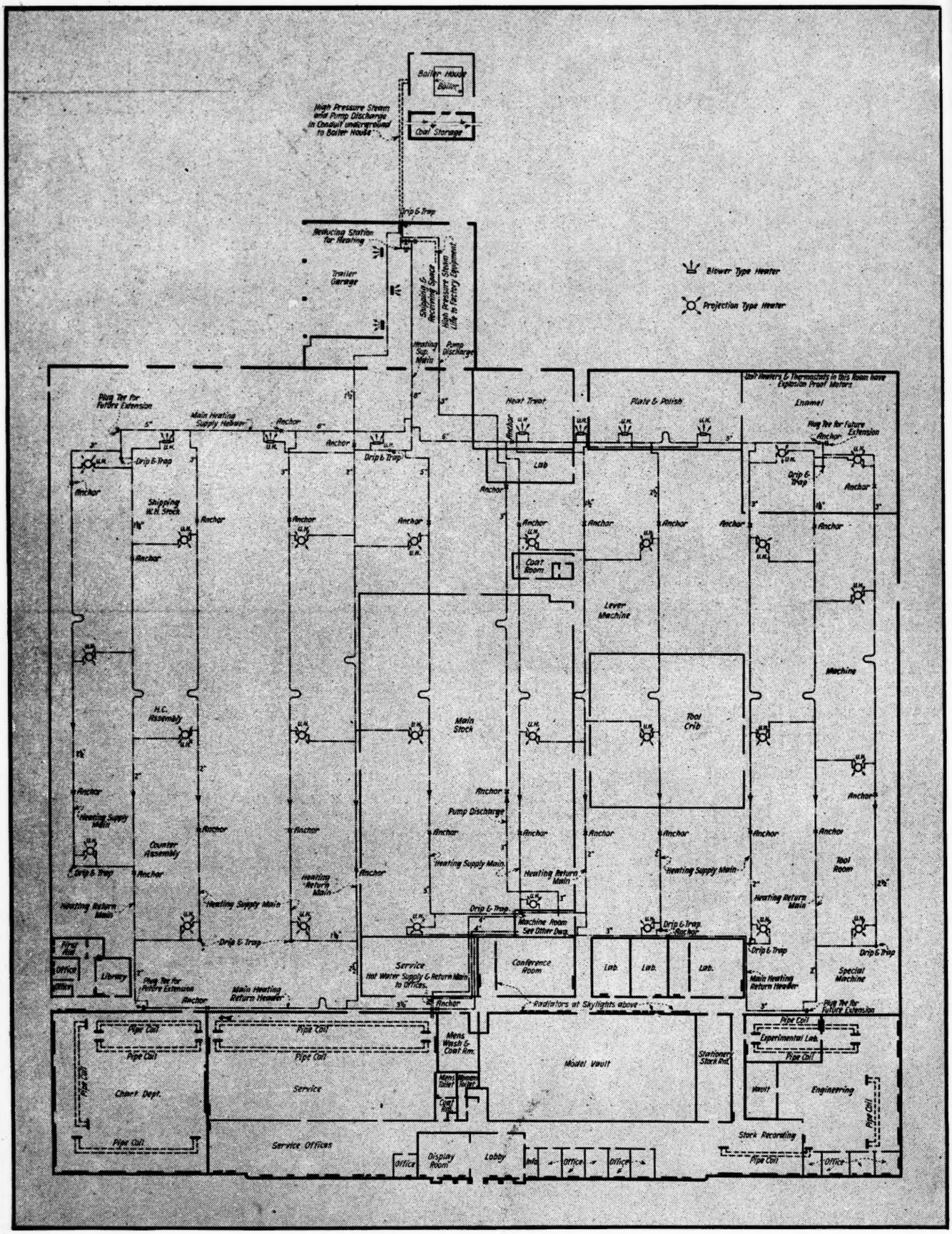

Fig. 2. General arrangement of the plant and offices showing location of heating units, factory piping, and boiler house.

the point of reduction the main runs overhead through the trusses to serve the overhead unit heaters and to a machine room in the factory where the steam passes through heat exchangers for heating the hot water to supply the office heating system and also to the domestic water heater.

Thus the heating is divided into two separate systems—an overhead steam unit system for the factory and a forced hot water system for the administration offices, experimental laboratories, and other office portions of the building.

Machine Room

In the machine room, the heat exchangers, pumps and auxiliary equipment are located. The arrangement of the apparatus is shown schematically in Figure 4. In two of the heat exchangers, the water for the office heating system is heated by the 30 lb. steam, while the third exchanger is provided for domestic hot water. This third unit also acts as the storage tank for domestic hot water, and is cross connected with a gas-fired water heater which can be used when the boilers are down or when, for any other reason, steam supply is not available.

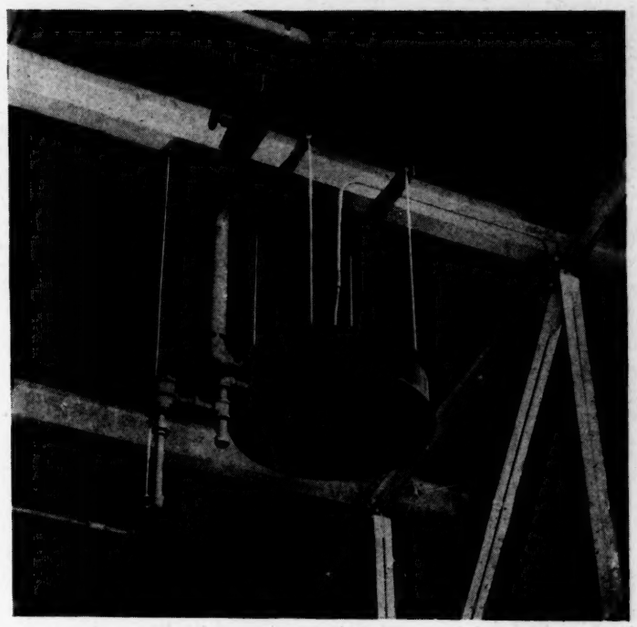

Fig. 3. A close-up of one of the projection types steam unit heaters in the factory portion of the building.

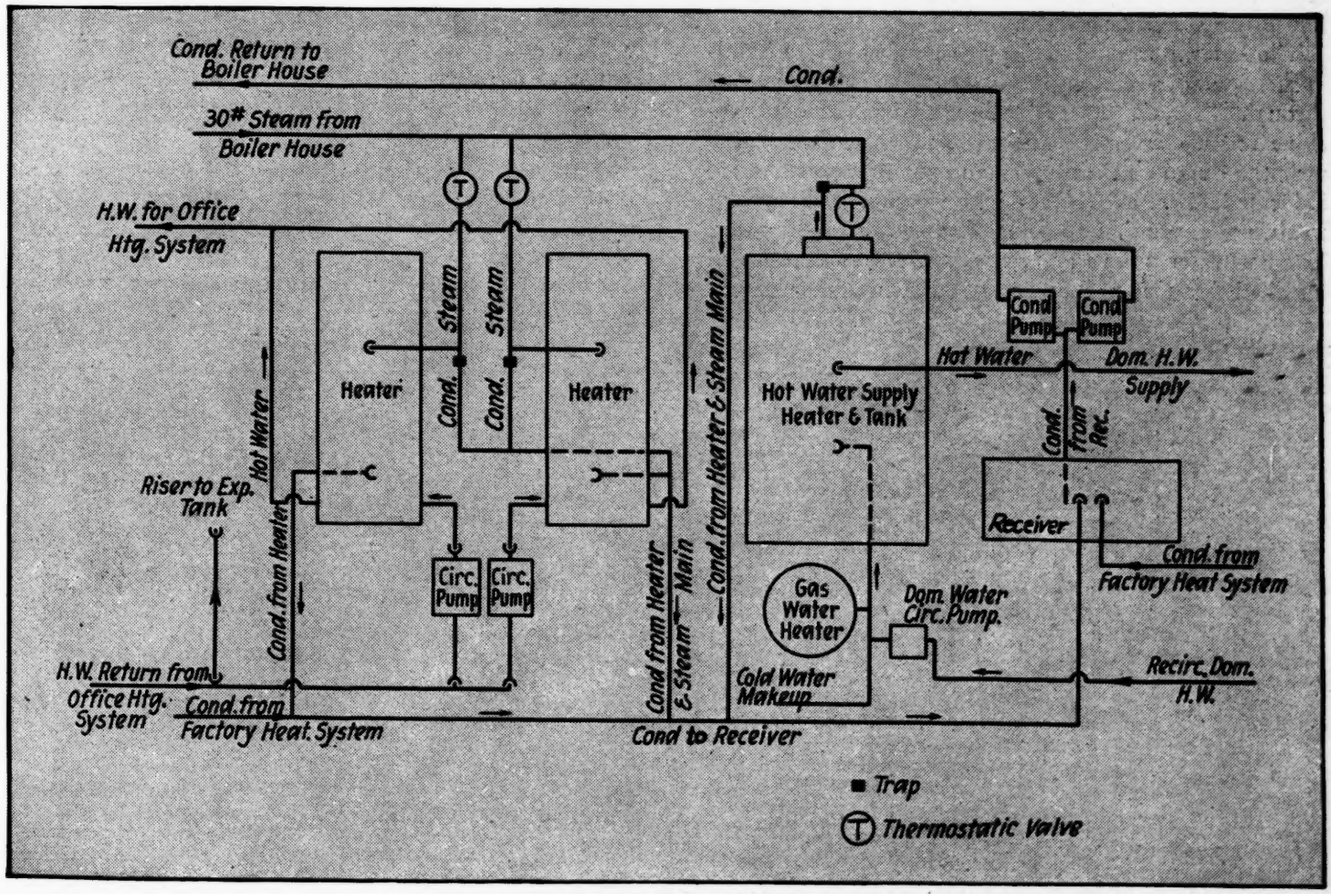

Fig. 4. Schematic drawing (not to scale) of equipment in the Machine Room where heat exchangers are located.

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Fig. 5. A typical view in the interior of the factory portion of the Toledo Scale plant.

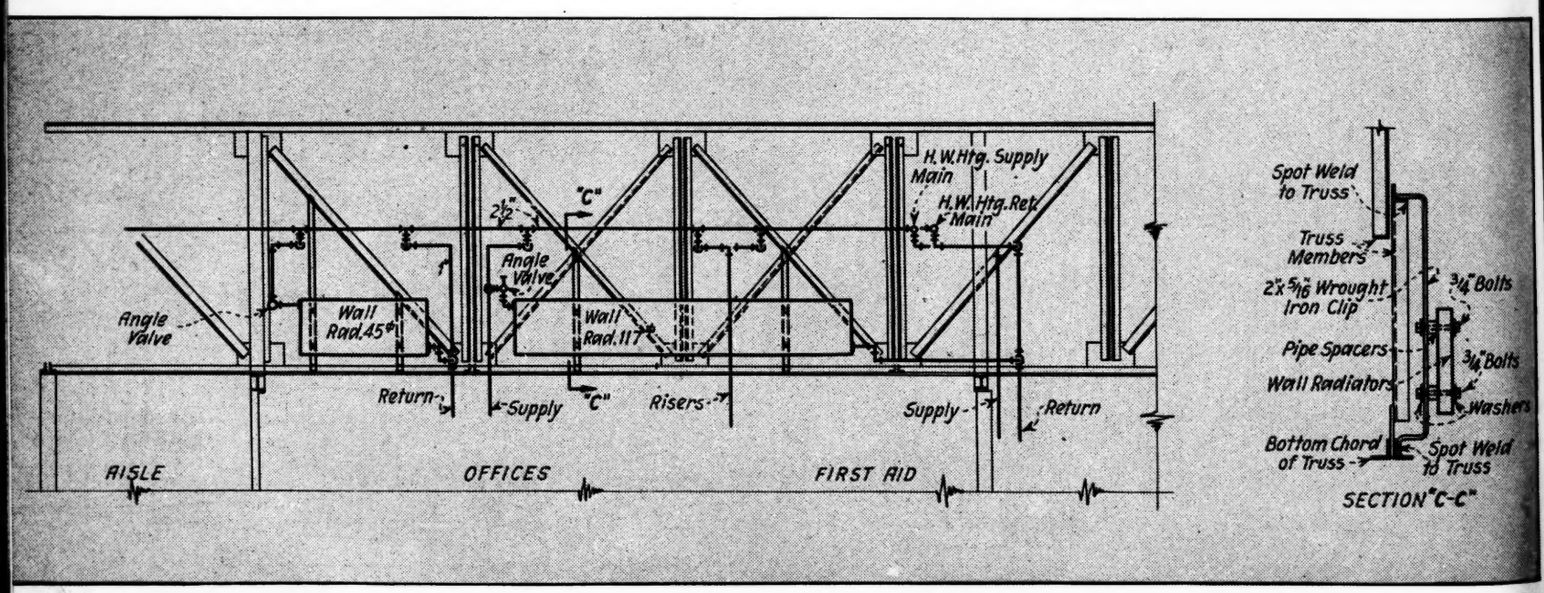
The heat exchangers are controlled by means of thermostatic valves in the steam lines. A dual control governs the temperature of the water in relation to the outside temperature; that is, as the outside temperature rises, the water temperature from the heaters is lowered to the temperature required to maintain the desired temperature in the offices (approximately 72F). These dual controls also have a unique feature which comes into play whenever the wind velocity is above normal. This extra feature of the control automatically steps up the supply water temperature 10F whenever the above condition occurs.

The hot water supplying office portion of the building is pumped through the heat exchangers; then through the radiators and coils and back to the machine room. An expansion line is taken off the return near the pump and run up to an expansion tank which is located 24 in. above the highest point of the system to always insure that all parts of same are full of water. The hot water pumps and heaters in this system are so installed that either pump can be run with either heater.

The main portion of the factory is heated by unit heaters. Direct horizontal suspended blower type unit heaters are located in the trusses near all large outside door openings. Elsewhere in the factory projection type unit heaters, located in the trusses, direct the air down to the floor in such a manner as to assure even distribution of heat. Each unit is controlled by a 3-position magnetic starter located in a convenient position, with Off, Hand and Automatic push buttons located in a starter cover.

The Automatic position controls thermostats set for any desired temperature between 50 and 80F. By placing in Hand position, it is possible, with this type of heater, to use the units for ventilation purposes in the

Fig. 6. Elevation of wall radiators and connections in a typical location at skylights. The drawing to the right below is the section CC.



summer, without disconnecting the thermostats.

Expansion bends are provided as shown in Figure 2 in the factory mains so as to allow for expansion. Expansion joints are used in the underground steam mains from the boiler house to the machine room and at the hot water circulating pumps.

Condensate returning from the factory unit heaters is discharged into a condensate return main in the trusses which flows by gravity back to the receiver in the machine room, then through the condensate return pumps, and returns to the boiler house through an overhead pump discharge line.

Office Heat

Radiators were required under the first floor windows for heating the office section, which meant that if steam were used there would have been either an underground return main or a return under the radiators along the wall. This being undesirable, a forced hot water system was selected; thus both the supply and return mains were installed on the first floor ceiling, with branches to the radiators above and below, and in this manner trouble with underground returns and unsightliness of return along the wall was eliminated.

Three types of heating surfaces were used in the administration portion of the building; cast iron radiators are employed along outside walls, except in the offices where concealed copper radiators are installed, while pipe coils are provided under skylights to take care of

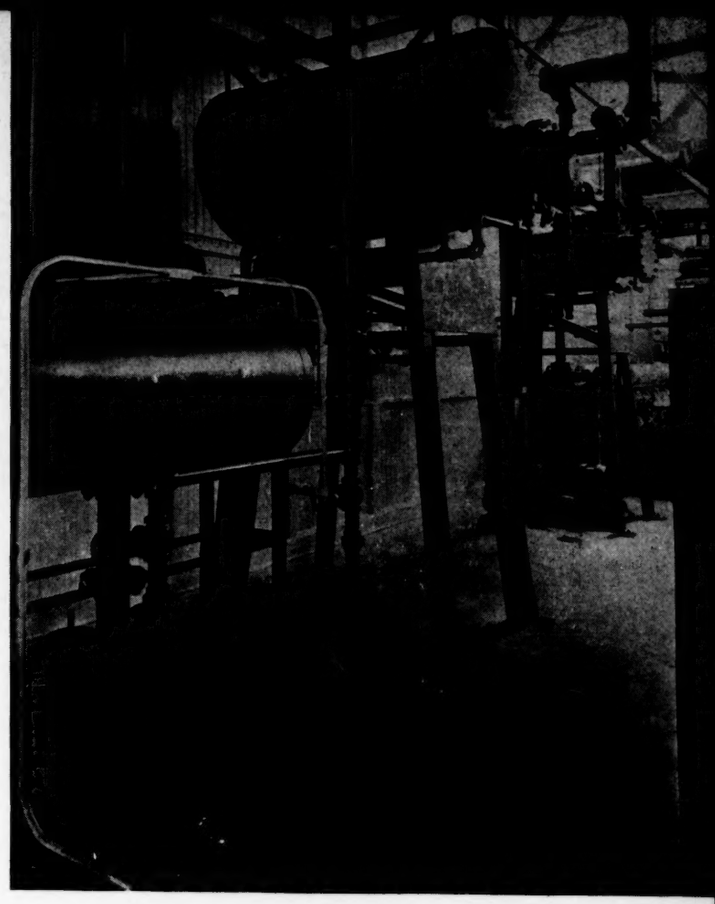


Fig. 7. A partial view of the Machine Room, with the receiver and condensation pumps in the left foreground, and one of the heat exchangers in the upper center.

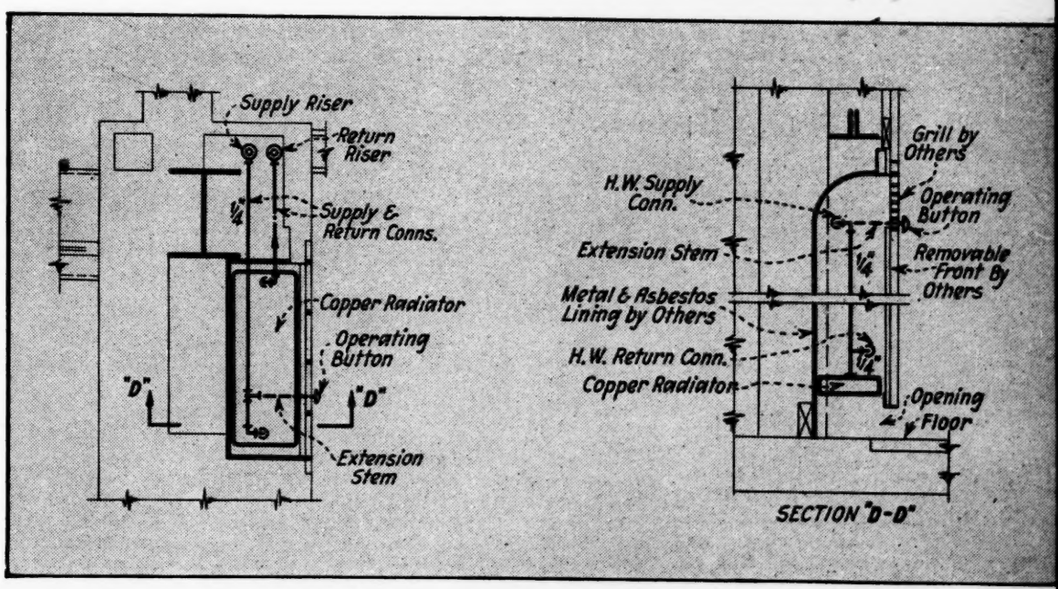


Fig. 8. A plan (left) and section DD (right) of the copper convector connections in the vestibule.

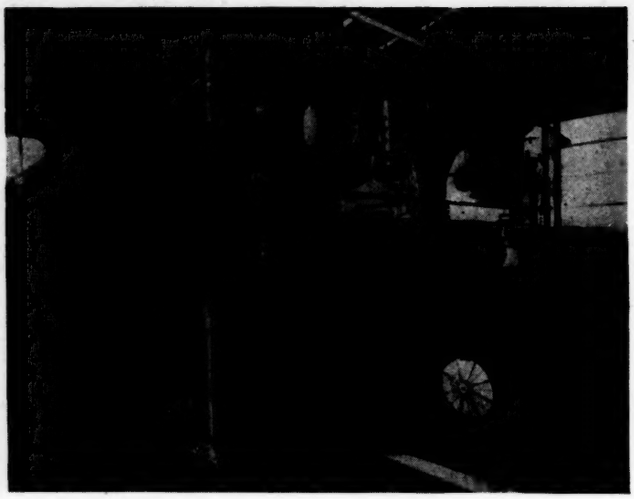


Fig. 9. The two boilers and stokers in the boiler house located to the rear of the factory portion of the Toledo Scale plant.

this part of the load and prevent down drafts of cold air.

The radiation in the one-story portion of the office was so designed that when the future second floor is installed and the coils in the skylights removed the remaining radiation along the sidewalls will be sufficient to heat this area.

Pipe in the heating system was welded throughout and welded fittings employed for elbows and tees excepting in piping over 6-in., which is flanged.

A system of exhaust ventilators was installed to serve the toilet rooms, corridors and waiting rooms. This system consists of a large exhaust fan which is connected to the ducts and registers in the various rooms and is of a sufficient size to adequately ventilate them and keep them free from objectionable odors.

An automatic sprinkler system is furnished throughout the building, with the exception of a dry pipe system in the shipping, receiving, and trailer garage.

Heat Distribution in High Factory Room

PROPER heat distribution in spaces with extraordinary high ceilings heated by radiators is difficult to provide. Furthermore, since there are few data available to show what the temperature distribution is in high-roofed spaces when radiators are used, designers frequently reject radiators from consideration for such installations. The accompanying figures are interesting in that they do provide performance data, which are not often found, and also since they show temperatures in a high ceiling space heated with a steel radiator which is finding wide application in industrial type buildings.

A middle western metal working plant abandoned its power plant about a year ago and now purchases steam for its own use from an adjacent plant. The old power plant building, with a 45 ft. roof, was then converted into a carpenter shop. The problem of heating this space was given careful consideration and ten of the radiators referred to above, were installed as shown on the accompanying plan. The building is 50 x 100 ft. in plan and consists of, primarily, one large room. The building is of brick construction, with large window area in wide walls, and with a concrete roof. Six-pound steam is fed to the 10 radiators.

Last winter, when the temperature was between 15 and 16° above zero, a series of temperature readings were taken in the building. The thermometers were located as shown on the sketches and readings taken every half-hour for three periods. The results are shown on the accompanying table.

While the temperature 2½ ft. above the floor averaged 68F, the temperature was slightly less than 72F two feet below the roof.

TEMPERATURE READINGS IN HIGH CEILINGED BUILDING

Thermometer	Therm. Location, Ft. Above Floor	Temperatures, F.			
		9:50	10:20	15:50	Average
1	43	72	71.5	72	71.8
2	35	71	71	71.5	71.2
3	25	69.5	70	70	69.8
4	15	70	70	70	70
5	14	—	70	70	70
6	10	70	70	70	70
7	8	—	69	69.5	69.8
8	5	68	69.5	69.5	69
9	—	66	67	67	66.6
10	2½*	69	69	69½	69.2
11		68	68	68½	68.2
12		70	70	69½	69.8
13		66	66	67	66.3
—	Outside†	15.5	16	15.5	15.7

*Average of all readings 2½ ft. above floor, 68F.
†Wind velocity outside, 8 m.p.h.

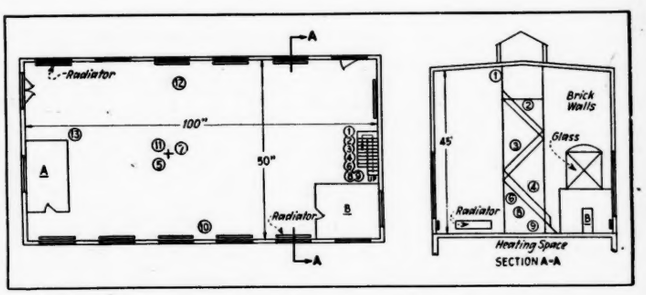


Fig. 1. A plan and elevation of the carpenter shop. The figures in circles indicate the location of thermometers as tabulated to the left.

WOODWORKING PLANTS

use exhaust ventilation to prevent clogging of machines, control fire hazards and to eliminate irritating atmospheric dust. Here is an outline of the latest information on how to design such an exhaust system.

By THEODORE HATCH† and R. B. NORTHRUP†

PROFITS IN AIR

NO. 8 OF A SERIES DEALING WITH INDUSTRIAL PLANT ATMOSPHERIC CONDITIONS

CONTINUOUS removal of shavings, chips and sawdust from wood working machines is necessary to prevent clogging of the machines, to control the fire hazard and to eliminate irritating atmospheric dust. Exhaust ventilation has been used for this purpose for many years and as a result the designs of hoods and other parts of the exhaust system have been highly developed and have become standardized, to a considerable extent, among ventilating engineers and contractors. This applies particularly to the layout of hoods and the required rates of air flow through them, air velocities in the exhaust pipes and the design of cyclone dust collectors.

All dust exhaust systems are basically similar in that they are comprised of hoods at the several points of dust production connected by branch pipes to a common exhaust main, which is connected in turn to an exhaust fan and central dust collector. The rate of air flow through each hood must be sufficient to insure effective dust collection and an air velocity is required in the pipes high enough to convey the collected dust

†Div. of Industrial Hygiene, N. Y. Dept. of Labor.

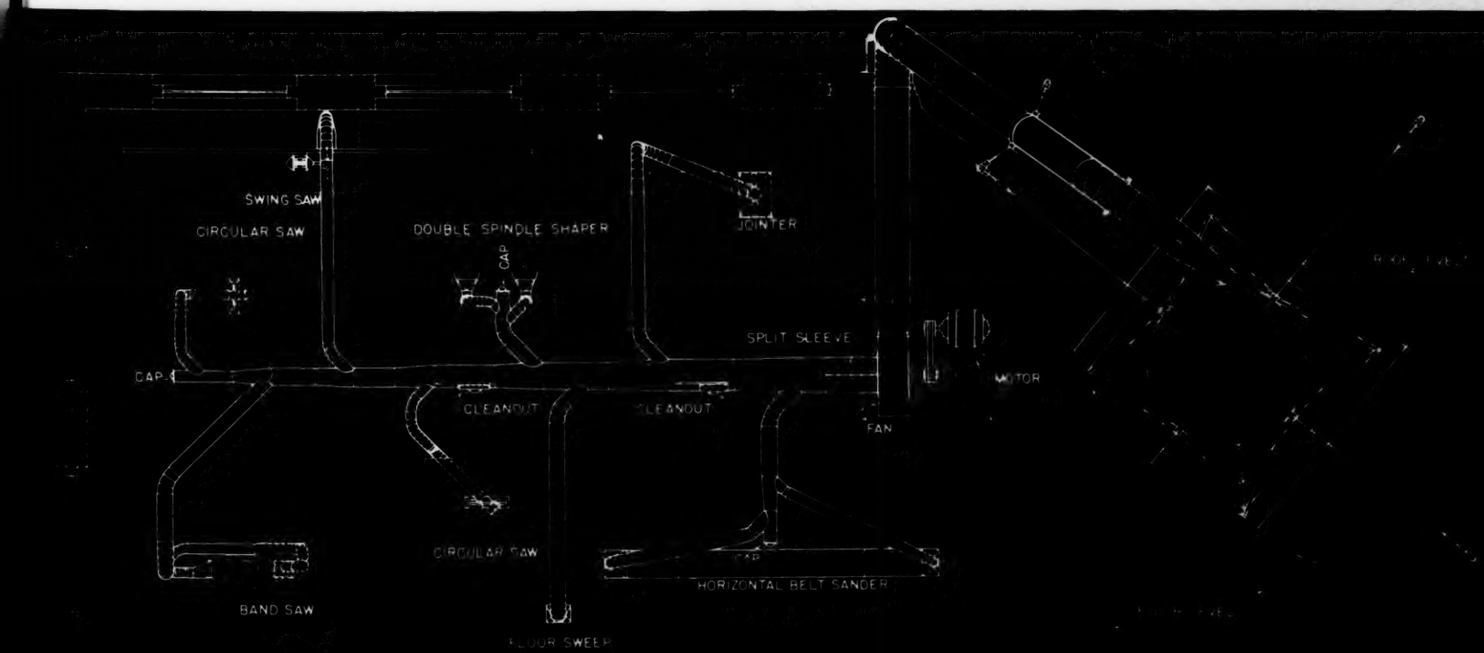
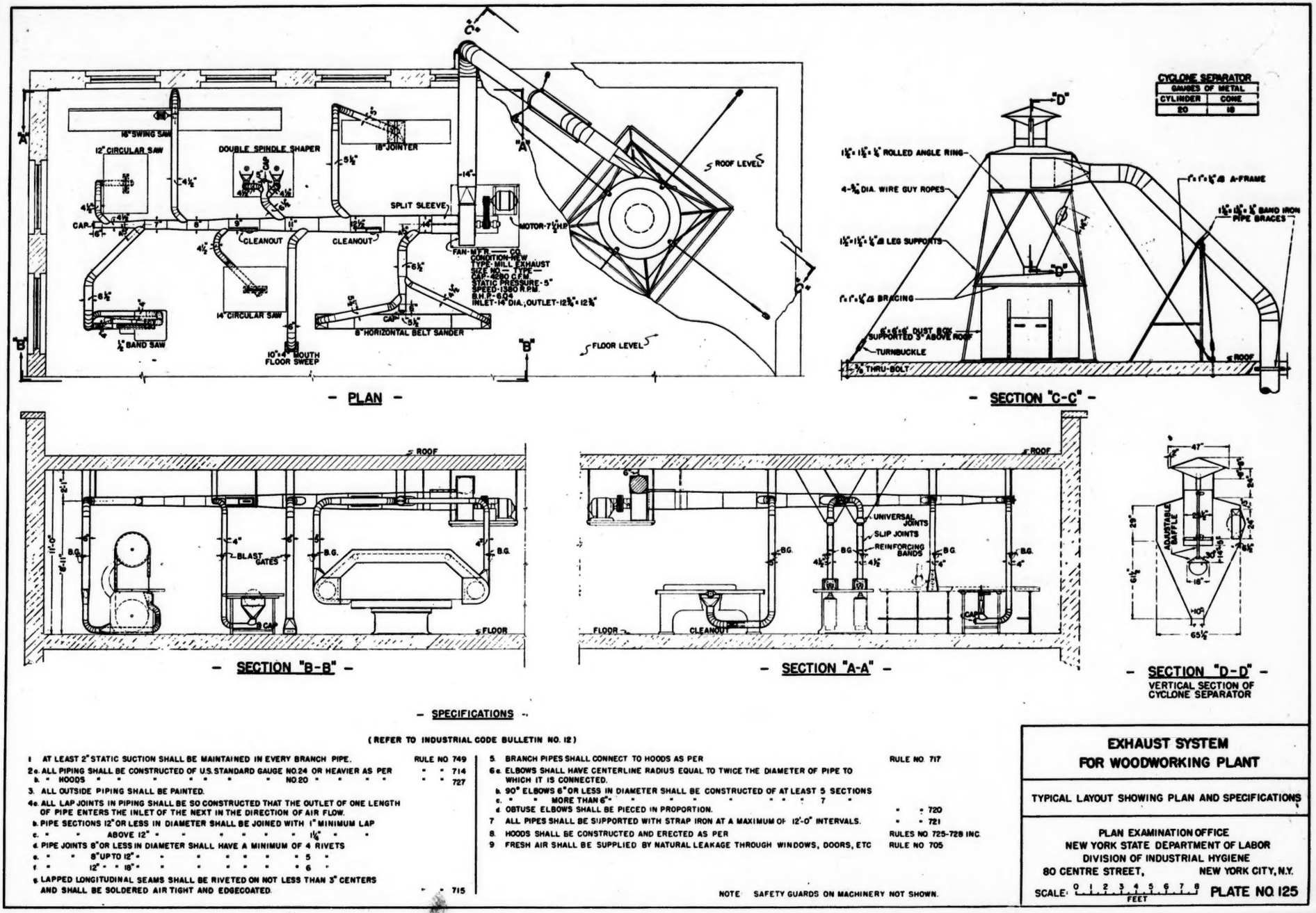


Fig. 1. Plan of a typical woodworking plant. Calculations for the design of exhaust system shown are included in this article.



- SPECIFICATIONS -

(REFER TO INDUSTRIAL CODE BULLETIN NO. 12)

1	AT LEAST 2" STATIC SUCTION SHALL BE MAINTAINED IN EVERY BRANCH PIPE.	RULE NO 749
2a.	ALL PIPING SHALL BE CONSTRUCTED OF U.S. STANDARD GAUGE NO.24 OR HEAVIER AS PER	" " 714
b.	" HOODS " " " " " " NO.20 " " " "	" " 727
3.	ALL OUTSIDE PIPING SHALL BE PAINTED.	
4a.	ALL LAP JOINTS IN PIPING SHALL BE SO CONSTRUCTED THAT THE OUTLET OF ONE LENGTH OF PIPE ENTERS THE INLET OF THE NEXT IN THE DIRECTION OF AIR FLOW.	
b.	PIPE SECTIONS 12" OR LESS IN DIAMETER SHALL BE JOINED WITH 1" MINIMUM LAP	
c.	" " ABOVE 12" " " " " " " 1½" " "	
d.	PIPE JOINTS 8" OR LESS IN DIAMETER SHALL HAVE A MINIMUM OF 4 RIVETS	
e.	" " 8" UP TO 12" " " " " " " 5 "	
f.	" 12" " " 18" " " " " " " 6 "	
g.	LAPPED LONGITUDINAL SEAMS SHALL BE RIVETED ON NOT LESS THAN 3" CENTERS AND SHALL BE SOLDERED AIR TIGHT AND EDGECOATED.	" " 715
5.	BRANCH PIPES SHALL CONNECT TO HOODS AS PER	RULE NO 717
6a.	ELBOWS SHALL HAVE CENTERLINE RADIUS EQUAL TO TWICE THE DIAMETER OF PIPE TO WHICH IT IS CONNECTED.	
b.	90° ELBOWS 6" OR LESS IN DIAMETER SHALL BE CONSTRUCTED OF AT LEAST 5 SECTIONS	
c.	" " MORE THAN 6" " " " " " " 7 "	
d.	OBTUSE ELBOWS SHALL BE PIECED IN PROPORTION.	" " 720
7	ALL PIPES SHALL BE SUPPORTED WITH STRAP IRON AT A MAXIMUM OF 12'-0" INTERVALS.	" " 721
8.	HOODS SHALL BE CONSTRUCTED AND ERECTED AS PER	RULES NO. 725-728 INC.
9	FRESH AIR SHALL BE SUPPLIED BY NATURAL LEAKAGE THROUGH WINDOWS, DOORS, ETC	RULE NO 705

NOTE SAFETY GUARDS ON MACHINERY NOT SHOWN.

EXHAUST SYSTEM FOR WOODWORKING PLANT

TYPICAL LAYOUT SHOWING PLAN AND SPECIFICATIONS

PLAN EXAMINATION OFFICE
NEW YORK STATE DEPARTMENT OF LABOR
DIVISION OF INDUSTRIAL HYGIENE
80 CENTRE STREET, NEW YORK CITY, N.Y.

SCALE: 0 1 2 3 4 5 6 7 8 FEET — PLATE NO 125

Fig. 2. Layout of a typical exhaust system for a woodworking plant, showing plan and specification of design and construction.

TABLE 1.—REQUIRED BRANCH PIPE DIAMETERS AND RATES OF AIRFLOW REQUIRED FOR THE EXHAUST SYSTEM IN FIG. 2

Machine	Size, In.	Branch Pipe No.	Branch Pipe Dia., In.	Rate of Air Flow, C.F.M.
Circular Saw	12	1	4	350
Band Saw	½	2	4	700
Swing Saw	16	1	4	350
Circular Saw	14	1	4	350
Double Spindle Shaper		2	4½	880
Jointer	18	1	5	550
Belt Sander	8	2	4	350
			5	550
Total				4080

to its final point of disposal. The branch and main exhaust pipes must also be proportioned so as to secure the proper distribution of air flow throughout the system, that is, each hood must take in its required portion of the total flow. The fan size and speed are selected to create a total rate of air flow not less than the sum of the rates of flow into the several hoods and finally the size of the dust collector must be determined to provide the necessary efficiency of dust separation without excessive power loss.

As stated before, these basic requirements have been rather completely standardized with respect to woodworking machines and the design procedure has been simplified to such a degree that only the most elementary calculations are required. In spite of this fact, the design requirements are not always understood and ineffective dust control frequently results because of failure to observe the simple rule of design. In the present article an outline of the common practices employed in the design of exhaust systems for woodworking plants is presented and these practices are discussed in connection with the typical layout shown in Fig. 2.

Layout

For best results the exhaust system should be compact with short lengths of exhaust pipe and the fewest bends possible. This is most effectively obtained by grouping the machines symmetrically about the fan.

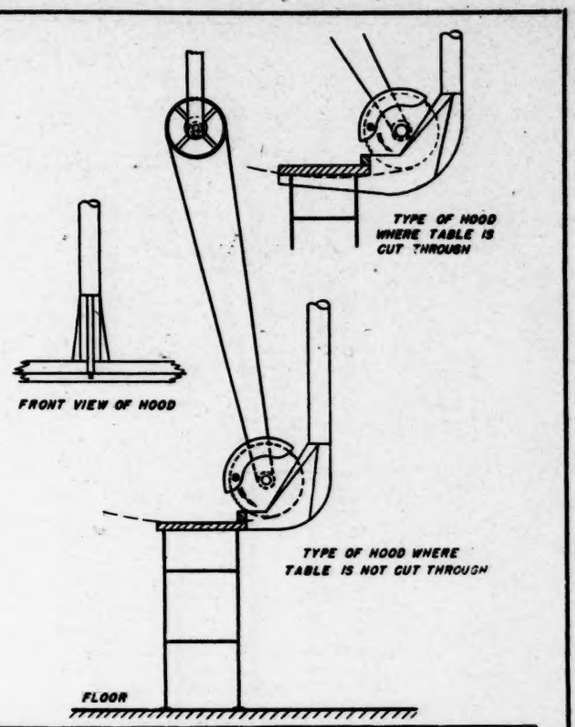


FIG. 3. STANDARD EXHAUST HOOD DESIGN FOR SWING SAW WITH RECOMMENDED PIPE SIZES

Swing Saw—Size, In.	Branch Pipe Diameters—In.
Up to 20 dia.	4
Over 20 dia.	4½

Generally the designer can do very little toward securing a compact system since the machines are already in place and the location of the piping and fan fixed by shop layout. However, the importance of a compact and symmetrical layout from the standpoint of power cost should be emphasized to the plant manager and every effort made to obtain the best possible arrangement. Frequently, in the case of a large and extensive shop, two or more (independent) exhaust systems with separate fans can be provided to good effect in place of one large system. The system shown in Fig. 2 may be considered as fairly compact.

TABLE 2.—CALCULATION OF PIPE SIZES IN FIG. 2 BY AREA LOAD METHOD

Branch	Branch Dia., In.	D^2	ΣD^2*	Header Dia., In.	H^2*	$\frac{\Sigma D^2}{H^2}$	Minimum Header Velocity, Linear Ft. Per Min.
1	4 to 4½	16	16	4½	20¼	0.79	3150
2A	4	16	16	—	—	—	—
2B	4	16	32	6 to 6½	36	0.89	3550
2	—	—	48	7	49	0.97	3900
3	4 to 4½	16	64	8	64	1.00	4000
4	4 to 4½	16	80	9	81	0.99	3950
5A	4½ to 5	20¼	20¼	—	—	—	—
5B	4½ to 5	20¼	40½	6½	42¼	0.95	3800
5	—	—	120½	11	121	0.99	3950
6	5 to 5½	25	145½	12½	156¼	0.92	3700
7A	5 to 5½	25	25	—	—	—	—
7B	4 to 4½	16	41	6½	42¼	0.96	3850
7	—	—	186½	14	196	0.95	3800

Total area load $= \pi/4 \times \Sigma D^2 = \pi/4 \times 186\frac{1}{2} = 146.5$ sq. ins. $= 1.02$ sq. ft.
Min. total air flow $= 1.02 \times 4000 = 4080$ c.f.m.

*ΣD^2 and H^2 are directly proportional to pipe area and are used here rather than areas to simplify calculations.

Exhaust Hoods

Standard designs for hoods and hood connections to the exhaust systems are available for most woodworking machines. A series of such standard hoods for several representative machines are shown in Figures 3 to 10. This series does not completely include all woodworking machines nor do the designs shown fit every situation. In many instances the hoods can be improved for particular cases. The designs shown, however, are the result of many years of experience on the part of the New York Department of Labor, ventilating contractors and others who contributed to their development. These hoods are provided with branch pipe

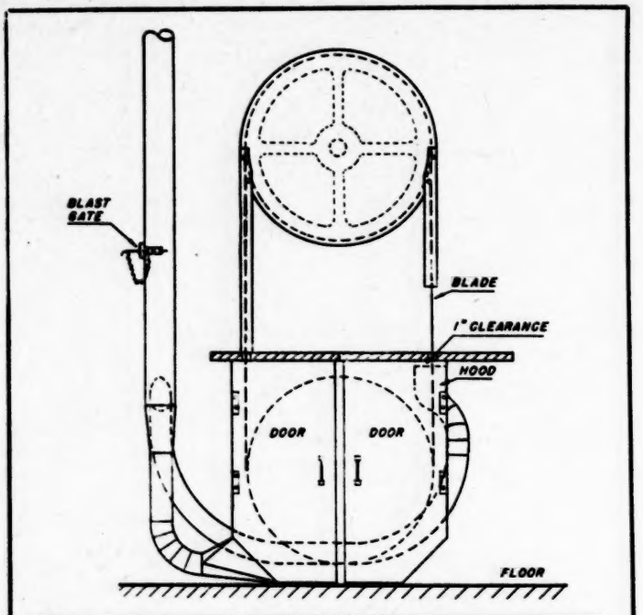


FIG. 4. STANDARD EXHAUST HOOD DESIGN FOR BAND SAW WITH RECOMMENDED PIPE SIZES

Band Saw—Size, In.	Branch Pipe Diameters—In.
Saw less than 2 wide	two pipes—4

connections of fixed diameters, as specified, for example, in the New York Industrial Code 12, which insure the proper rate of ventilation in each case when an air velocity of 4000 linear f.p.m. is maintained in the branch pipe. The hoods are assumed to have an average entrance coefficient of 0.7 (which is equivalent to an entrance loss of 1.0 VP); hence, the static suction at a point in the branch pipe three diameters back of its connection to the hood will be equal to 2.0 VP. In order to secure the required rate of ventilation, therefore, the static suction at this point must be 2.0″, w.g. (1.0 VP = 1.0″, w.g. for 4000 linear f.p.m.). For the system shown in Fig. 2 the hoods, branch pipe diameters and rate of ventilation shown in Table 1 are required.

Pipe Sizes

The diameters of branch pipe connections are found, as above, from the machine or cutter head size. As a first approximation the size of the main piping is determined by the *area load* method, that is the area of the pipe at any section is made at least equal to the sum of the areas of all the branch pipes connected to the system between the section in question and the remote end. This results in a velocity of 4000 linear f.p.m. through the entire system if balanced flow is assumed. The *area load* method of calculation, however, does not insure a balanced system, particularly if the system is extensive and long branch pipes are employed. It is common practice, therefore, to increase the pipe diameters in long runs of horizontal piping in order to reduce resistance and thus improve the distribution of flow. This is permissible for most wood dust since the minimum conveying velocity is actually less than 4000 linear f.p.m. For all materials except wet chips, it is safe, in our experience, to reduce the velocity to 3000 linear f.p.m. and in certain cases to even lower values. Diameters are generally increased in the horizontal runs of branch pipes by one-half inch; that is, from 4-in. to 4½-in., 5-in. to 5½-in., etc.

This procedure was employed in the present case and the calculations involved are shown in Table 2. It will be noted, that H^2, the square of the diameter of the submain or main pipe, is in every case equal to or larger than ΣD^2, the sum of the squares of diameter of all the branch pipes connected to the system beyond the section in question. These calculations do not in-

FIG. 5. STANDARD EXHAUST HOOD DESIGN FOR BELT SANDER WITH RECOMMENDED PIPE SIZES

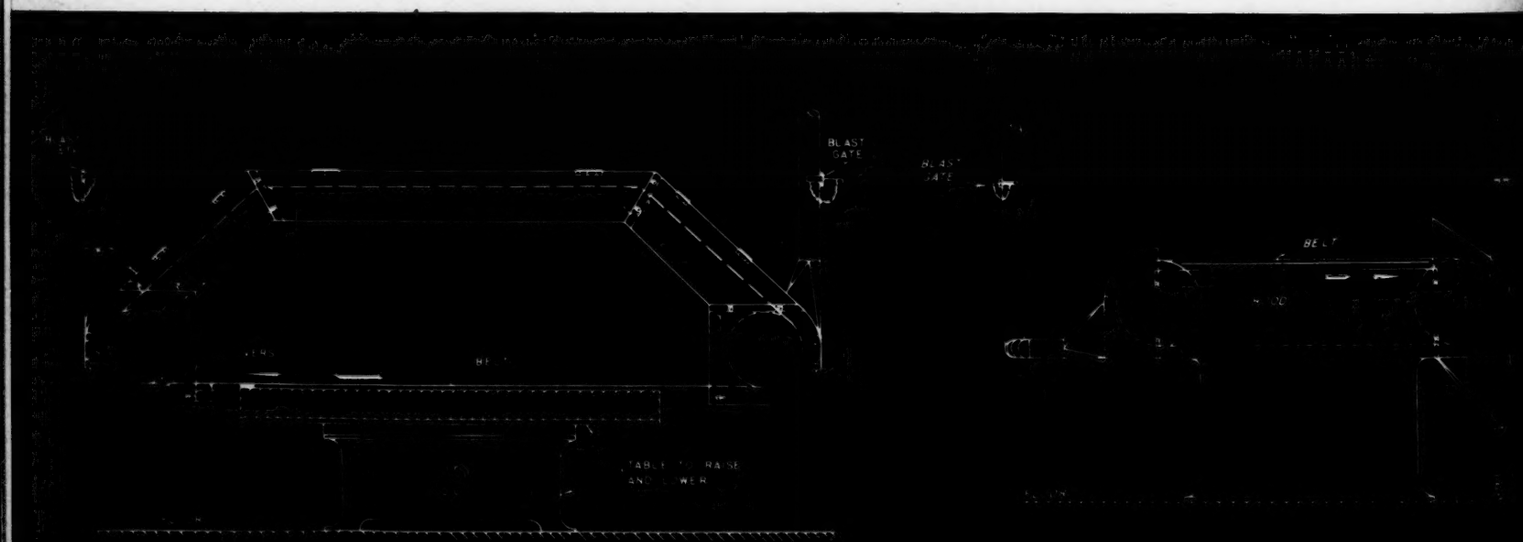
Belt Sander (Bottom Run of Belt Used)—Size, In.	Branch Pipe Diameters—In.
Less than 6 wide	two pipes—4½, 4
6 to 9 wide	two pipes—5, 4
Over 9 to 14 wide	two pipes—6, 4½
Over 14 wide	two pipes—7, 5

NOTE: Larger branch pipe at up-run of belt. Note louvers inside hood to distribute flow.

FIG. 6. STANDARD EXHAUST HOOD DESIGN FOR BELT SANDER WITH RECOMMENDED PIPE SIZES

Belt Sander (Top Run of Belt Used)—Size, In.	Branch Pipe Diameters—In.
Less than 6 wide	two pipes—4½, 4
6 to 9 wide	two pipes—5, 4
Over 9 to 14 wide	two pipes—6, 4½
Over 14 wide	two pipes—7, 5

NOTE: Larger branch pipe at up-run of belt. Note louvers inside hood to distribute flow.



clude the area of the branch pipe from the floor sweep since this is not in continuous active use and is kept closed except when clearing the floor. This is in accord with general practice.

Fan Size

The fan size is also determined by the *area load*, that is, its inlet and outlet areas are made at least equal to the sum of the areas of all the branch pipes. This means that the velocity at the inlet and outlet of the fan will be not more than 4000 linear f.p.m. and for the average dust exhaust system the fans thus selected will operate close to its point of maximum efficiency.

The fan speed and horsepower are obtained from the rating table of the fan manufacturer. In order to use the rating table, the total rate of air flow and the overall resistance of the system must be known. The former is given directly by the product of the area load (in sq. ft.) and the pipe velocity which in this case is 4000 linear f.p.m. To determine the latter it has been common practice to add together the following:

1. Static suction at hood.
2. Friction loss in branch pipe (and elbows) connecting to the most remote hood or other controlling hood having the longest branch pipe length.
3. Friction loss in main exhaust and discharge pipes.
4. Loss through cyclone, including discharge from the cyclone.

This sum includes the velocity pressure on the inlet side of the fan since the static suction at the hood rather than the hood entrance loss is used in the calculation. The result, therefore, is not the true fan static since by definition, this does not include the inlet velocity pressure. However, the error is on the safe side and provides a margin of safety to take care of the extra resistance due to poor pipe construction and the added flow required to correct for imperfect distribution of flow. The calculations for the system under discussion are shown below and from these data and the fan rating table, the fan specifications, as shown, were obtained.

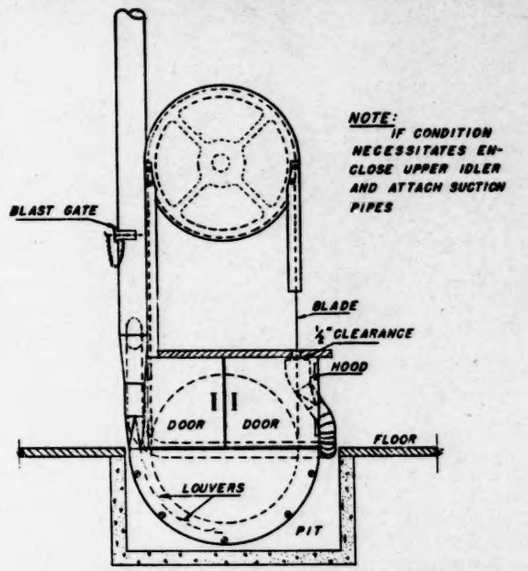


FIG. 8. STANDARD EXHAUST HOOD DESIGN FOR BAND RESAW WITH RECOMMENDED PIPE SIZES

Band Resaw—Size, In.	Branch Pipe Diameters—In.	
	Up-Run	Down-Run
Blade 2 to 3 wide	5	4
Over 3 to 4 wide	6	5
Over 4 to 6 wide	7	5
Over 6 to 8 wide	8	5

FIG. 7. STANDARD EXHAUST HOOD DESIGN FOR JOINTER WITH RECOMMENDED PIPE SIZES

Jointer—Size, In.	Branch Pipe Diameters—In.
Up to 6 knives	4
Over 6 to 12 knives	4½
Over 12 to 20 knives	5
Over 20 knives	6

NOTE: A ½" space is left between the hood and table to allow for the entrance of the required amount of air. This is necessary to insure an adequate pipe velocity to convey the collected material.

Distribution of Flow

The foregoing calculations relative to resistance and the fan speed required are based upon the assumption

FIG. 9. STANDARD EXHAUST HOOD DESIGN FOR CIRCULAR SAWS WITH RECOMMENDED PIPE SIZES

Circular Saw—Size, In.	Branch Pipe Diameters—In.
Up to 16 dia.	4
Over 16 to 24 dia.	4½
Over 24 dia.	5

NOTE: The hood is not attached closely under the table. A ½ in. space is left to allow for the entrance of the required amount of air. This is necessary to insure an adequate pipe velocity to convey the collected material.

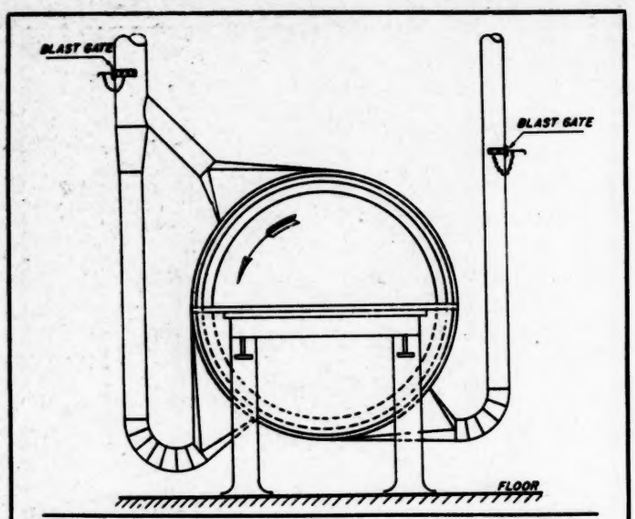


FIG. 10. STANDARD EXHAUST HOOD DESIGN FOR DISC SANDER WITH PIPE SIZES

Disc Sander—Size, In.	Branch Pipe Diameters—In.
Up to 12 dia.	4
Over 12 to 18 dia.	4½
Over 18 to 26 dia.	5
Over 26 to 32 dia.	two pipes—4
Over 32 to 38 dia.	two pipes—4 and 5
Over 38 to 48 dia.	three pipes—two—4, one—5

TABLE 3.—SYSTEM RESISTANCE, FIG. 2

1. Static Suction at Hood, Resistance, Inches of Water 2.0

2. Longest Branch (Band Saw):

Dia., In.	Length Ft.	Length Equiv. Dia.	Bends* 90°	Bends* 45°	Length of Bends in Equiv. Dia.	Total Equiv. Length in Dia.	Length in Dia. for 1 VP Loss	Resistance in Terms of VP	Resist., In. H_2O
4	7.5	22.5	2	1	16	38.5	40	$\frac{38.5}{40} = 0.91$	0.91
6	6.0	12.0	1		6	18.0	40	$\frac{18}{40} = 0.45$	0.35
6½	6.0	11.0		1	4	15.0	40	$\frac{15}{40} = 0.37$	0.21

3. Entry Loss = 0.25 VP 0.21

4. Header

7	3.0	5.1				5.1	40	$\frac{51}{40} = .13$	0.13
8	3.0	4.5				4.5	45	$\frac{4.5}{45} = .10$	0.10
9	3.5	4.7				4.7	45	$\frac{4.7}{45} = .11$	0.11
11	4.5	5.0				5.0	45	$\frac{5.0}{45} = 0.11$	0.11
12½	4.5	4.3				4.3	45	$\frac{4.3}{45} = 0.10$	0.10
14	34.0	29.0	1	2	10	39.0	45	$\frac{39}{45} = 0.87$	0.87

5. Cyclone Loss = 1 VP 1.00

6. Total Resistance (Including 1 VP at Inlet) 5.10

*One 90° bend equivalent to 6 pipe diameters in length
One 45° bend equivalent to 4 pipe diameters in length

that the velocity in the branch pipes at their connections to the hoods will be uniform at 4000 linear f.p.m., in other words, it assumes a balanced system. The assumption is not a correct one and consequently the fan will have to operate at a higher speed in order to produce 2.0 ins. static suction at the most remote hood. Since the system is fairly compact and horizontal runs of branch pipe diameters were increased ½-in., the distribution is more nearly in balance than would be the case with an extensive system having long branch pipes and pipe sizes based directly upon area load. Complete calculations in the present case by the step-by-step method show that the actual flow through the system must be approximately 4400 c.f.m. and the resistance (including inlet velocity pressure) will be 5.7 in. The fan will therefore have to operate at a slightly higher speed to produce 2.0 ins. static suction at the most remote hood.

Cyclone Dust Collector

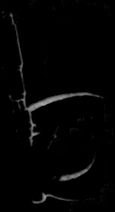
A standard cyclone dust collector having an inlet velocity of approximately 4000 linear f.p.m. is shown. Its diameter, cylinder height, cone length, diameter and length of outlet pipe and other details of design are taken from a standard table of dimensions used by the New York Department of Labor for many years. It is not offered as necessarily the most effective design but experience shows that it provides efficient separation for coarse wood dust. For fine dust from sanders and the like a cloth filter is required for effective dust collection.

Construction

Typical specifications for the construction of the system are shown on the plan. These include:

1. Elbows with center-line radius equal to 2 pipe diameters and made up of 5 or 7 pieces, as required.
2. Minimum gauge of metal in pipes and cyclone as shown.
3. Pipes with lapped, securely riveted and tightly soldered joints.
4. Cleanouts located every ten feet.
5. Pipe supports every twelve feet.
6. Fan and motor properly mounted.
7. Cyclone securely supported and anchored.
8. Tight dust storage chamber under cyclone.
9. Hoods well constructed, free from rough edges, and located so as to be most effective.

TOOL



MAKING

SKILSAW, INC.,

builds a new plant, offices, and research quarters in Chicago. Selects forced hot water for its heating system with unit heaters in the factory space and copper convectors in the offices.

By H. R. COLEMAN†

A 70% increase in business during the first half of 1939, due to the increasing popularity of its line of high efficiency portable electric tools has twice caused Skilsaw, Inc., of Chicago, to expand its new office building and factory, built only last year. The new factory and office now represent three times the space previously occupied by Skilsaw and provide more than five times its previous capacity.

Departmentalization of production, storage and handling facilities in an efficient, logical layout has been applied to take maximum advantage of daylight. Unusual modern features were introduced by the use of color and special treatment of brick and glass block in the exterior. The two-story office section extends across most of the 140-ft. landscaped facade, and the plant proper has an overall depth of 280 ft., with an additional 220 ft. available for future expansion, which would more than double the original structure.

Four 30-ft. aisles and one of 20 ft. which flanks an existing structure have been provided in the plant which has two monitors with 20 ft. clearance. Con-

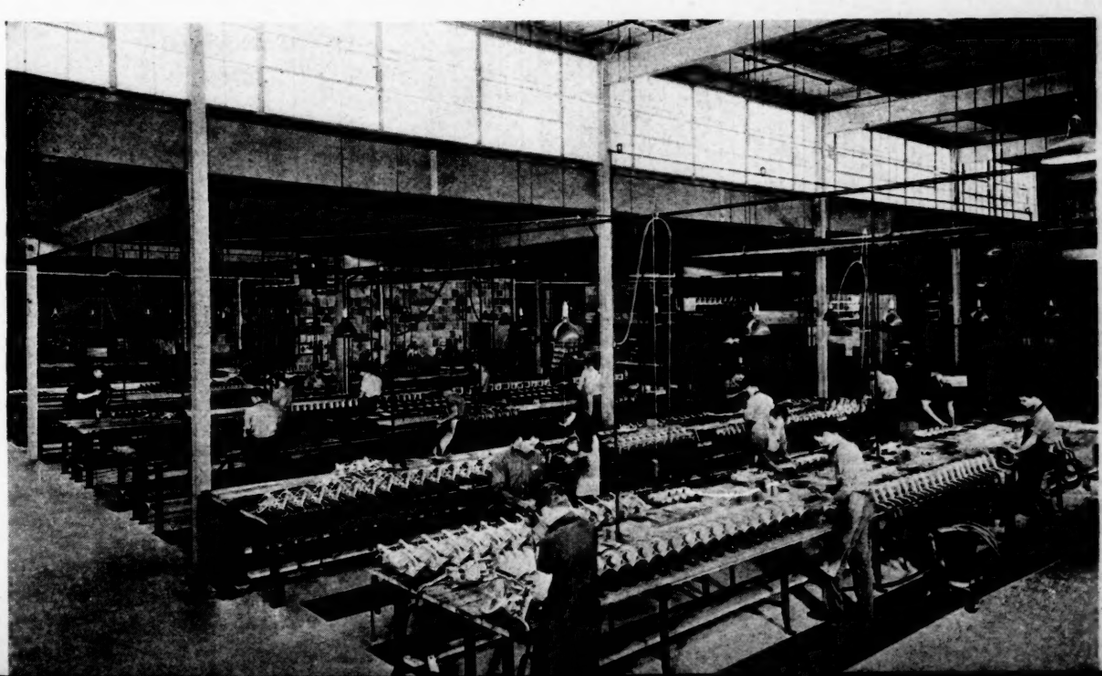
†Vice-president, Force-Flo Division of The Kehm Corp., Chicago.

THIS INSTALLATION

Owner—
Skilsaw, Inc., Chicago

Architects and Builders—
The Austin Co., Cleveland

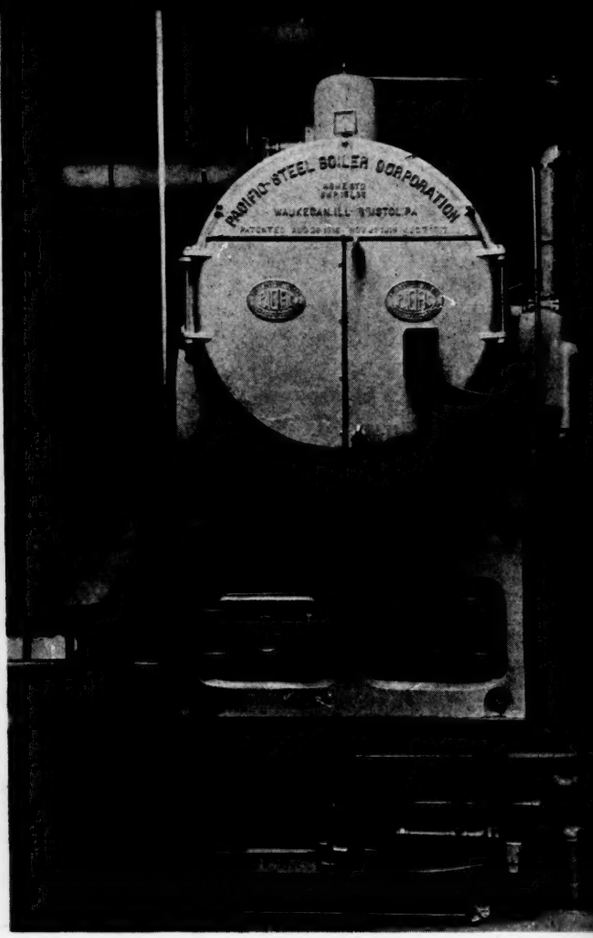
Heating Contractor—
Thomas Conlin Co., Chicago.



Assembly room showing benches on which the portable electric tools are assembled. The boiler room is situated behind the hollow tile portion seen in the background. A unit heater is visible toward the left.

PROFITS IN AIR

NO. 9 OF A SERIES SHOWING HOW INDUSTRIAL PLANTS PROMOTE PROCESSES AND PROFITS BY SCIENTIFIC CONTROL OF AIR CONDITIONS



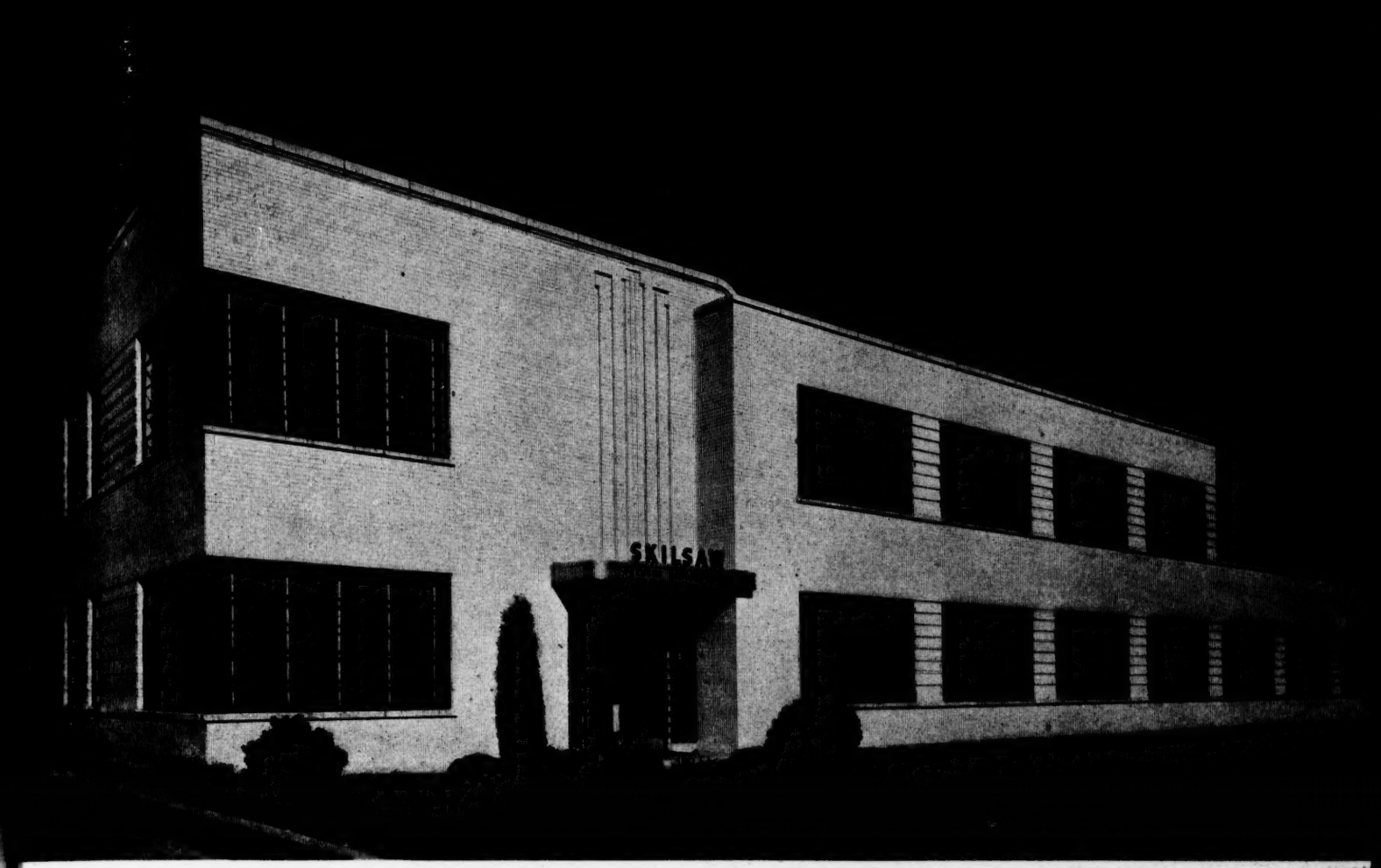
1 Continuous sash provides ideal illumination for tool room and machining operations which are concentrated in this area. Unit heaters installed throughout the plant are thermostatically controlled.

2 One of the offices showing how well the modern lines of the convectors blend with the functional character of the desk.

3 Display room where more than 50 types and sizes of portable electric tools are displayed. This room and other office spaces are heated with wall type convectors.

4 Boiler and oil burner in the Skilsaw plant. The hot water circulating pumps and return mains are shown to the left, indirect coil type heater and storage tank at the right, and expansion tank at the ceiling.

Top of Next Page. Exterior of Skilsaw's factory and office which is located in Chicago. Unusual modern features were introduced by the use of color, brick and glass blocks in the exterior.



tinuous sash encloses the temporary rear wall and provides ideal working conditions for the tool room and machine operations which are concentrated in this area. All machines in this section receive power through a bus distributing system which extends the full width of the building and permits the running of electric conduit overhead direct to each operating unit. Benches upon which the company's process products are assembled have been laid out parallel to the monitors to provide even distribution of daylight.

Careful thought was given to the location of offices experiencing the heaviest traffic. The purchasing agent was placed just a step from the entrance and the plant superintendent just beyond him, with doors from his office into both the front office lobby and plant. Executive, sales and the general service department offices are on the second floor. For the convenience of salesmen and customers a large display and conference room has been provided.

The owners and builders decided that a forced hot water heating system would be particularly suitable for light manufacturing and for the office portion of the building. The building is 280 ft. x 144 ft. with a total B.t.u. per hour heat loss of 2,730,500 of which 2,273,100 B.t.u. per hour is provided by unit heaters in the factory and 457,400 by copper convectors in the offices.

A single-main distribution system is used with supply and return shunt tees at each radiator and heater connection. This fitting diverts the flow of water from the one pipe main and gives smooth and positive delivery of hot water from the top of the main and return of cooled water to the bottom of the main.

As in most factory buildings of this type, the concrete slab is laid flat on fill or cinders which always presents the problem of running underground return mains. The single main overcomes this difficulty since it is possible to feed down as well as up to radiation and the main, as in this case, can be run in the ceiling of the first floor office space and all mains and risers concealed.

A frequently encountered problem in factory heating is the widely varying heating effect in the factory, where unit heaters are used, and in the offices heated by radiators. The tendency in these cases is often to overheat the offices with resulting fuel waste and discomfort. With the Skilsaw plant these two different type spaces are zoned by the use of two circulating pumps—a 1½ hp. pump being employed for the unit heater zone and a 1/3 hp. pump for the convector zone.

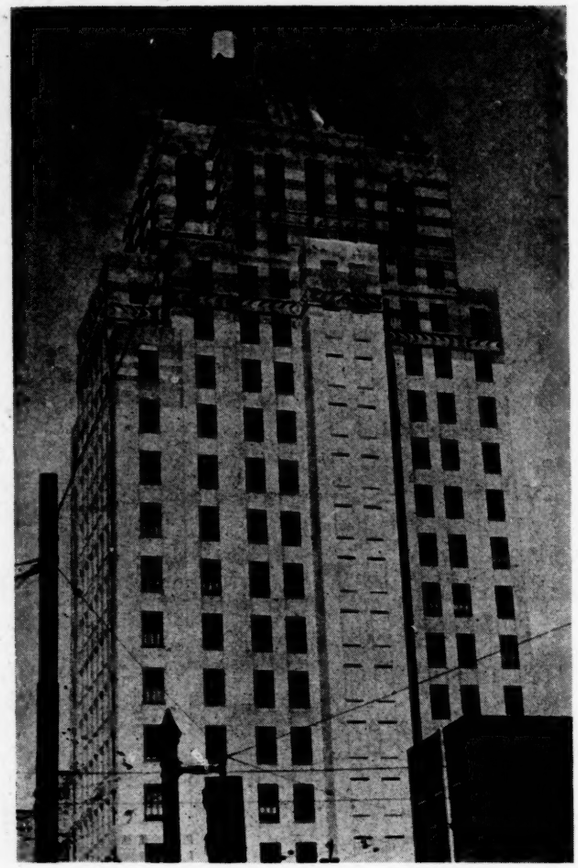
The office space is controlled by a centrally-located thermostat while the unit heater zone is furnished water by continuous operation, with the boiler temperature set each day according to outside weather conditions. Each unit heater is controlled by a separate thermostat. Since radiators and unit heaters are sized at 240 B.t.u. per hour, the boiler temperature is set at 225F when it is — 10 °F outside. The use of high temperature water is now considered highly practical and where initial cost is a factor units can be further reduced in size with a correspondingly higher boiler temperature necessary.

During the first season that the plant was in operation, a very low operating cost is reported by the owners, who state that their operating cost for 12 months is less than in their old factory building, which was about one-third as large as the present structure.

15 Story Shaft Houses Conditioning Rooms in Modernized Office Building

AN unusual construction feature was involved in the recent air conditioning of the 17-story Merchants National Bank Building in Mobile, Ala., an office building with a bank and stores on the ground floor.

It was not practicable to take up any valuable space in the building for equipment, since it is a 100% rented highly desirable office building. Consequently a masonry shaft was built alongside the building from bottom to top. In this shaft are housed the fan units on each floor (the fan rooms also serving as plenum chambers), water lines, and other risers. The whole project affords an example of how an existing building may be air conditioned without taking up space which may be at a premium.



Rear view of the 17-story Merchants National Bank Building, Mobile, showing the 15-story shaft added to accommodate fan rooms and risers.

The shaft is constructed of structural steel frame welded to the building columns at each floor. The shaft is finished in face brick with waterproofing behind and a structure of steel columns filled with glass wool insulation and finished inside with a cement plaster completes the shell. The floors are of concrete. The total weight of the shaft with equipment is only slightly more than the weight of the solid 13 in. brick wall removed to attach the shaft.

The building is fully air conditioned, including the bank and stores on the ground floor and offices above. It is served by two 125 hp. compressors installed in a basement annex. This air conditioning system is of 220 tons capacity. The drug store on the first floor is supplied from a separate direct expansion system of 10 tons capacity in order to allow operation of this area at different hours from those kept by the office building.

Each floor of the office building from the third to the fifteenth, inclusive, has a fan unit; two more are in the peaked roof to provide air for the top floors; still another is on the third floor to provide conditioned air for the banking quarters and for the second floor of the office building. The total air circulated is 86,000 c.f.m., serving 75,000 square feet of flow area.

Each floor is divided into two zones, the air volume being proportioned between the two zones by a splitter damper. For summer operation the temperature of the floor is held by a return air thermostat. A master zone thermostat located in each zone on one floor only operates the splitter dampers on all floors to correctly proportion the zone supply as the sun effect varies. All these thermostats are reset by a master compensator providing automatic compensated control so that the inside temperature is varied according to a schedule as the outside temperature varies.

For winter control the temperature is held constant at the discharge of the units and heat loss is taken care of by direct radiators previously installed in the building. An arrangement is also provided so that the return air thermostats can be used to control the heating in the conditioners so that these may be used to heat without any direct radiation in mild weather. The control of the banking system is essentially the same as for the typical floors.

Ductwork extends down the corridors on the various floors and is furred in, the height of the ceiling and the flat type ducts making this possible.

Cooling water is supplied from an 8 in. cased well, 75 feet deep, bored in the sidewalk area and then enclosed with the pump within the basement area adjacent to the compressors. This well was specified to deliver 350 g.p.m., but actually supplies 577 g.p.m. This water as it comes from the well is at 68F, whereas city water averages 85F, so that a distinct economy is effected in the condensing processes. Also a saving is thus made in water bills. The water is wasted to the sewer after use. A separate closed circulating water system supplies hot water to the conditioners in winter and cold water in summer.

Consulting engineers on the job were Newcomb & Boyd of Atlanta; the general contractors were Barge-Thompson Co., and the air conditioning contractor was York Ice Machinery Co., Atlanta office. The fan shaft was designed by R. G. Lose, structural engineer, Atlanta.

CHICAGO

welcomed during the week of January 15-19 refrigeration and air conditioning men who attended the 2nd All-Industry Refrigeration and Air Conditioning Exhibition and five conventions, including those of the American Society of Refrigerating Engineers and refrigerating and air conditioning manufacturers, jobbers, dealers and service men.

George F. Hulse, newly elected president American Society of Refrigerating Engineers

Jesse W. Page, Jr., newly elected president of the National Air Conditioning Association

Gaither Pratt, Retiring President American Society of Refrigerating Engineers

S. Forbes, president of the Refrigeration Equipment Manufacturers Association

Leo H. Gorton, retiring president of the Refrigeration Supply Jobbers Association

Gordon [illegible], president Refrigeration

..Here Is What Happened

(Above) Fenwick of Pittsburgh Lectrodryer addressing the RSES on dehydration of refrigerating equipment.

(Left) P. B. Reed, addressing RSES on oil charges for refrigerating equipment.

W. S. Bodine of Carrier Corp. (right), speaking before the ASRE conference on corrosion.

DESPITE a 13 below zero cold spell and a blizzard which blocked traffic for days, over 7500 air conditioning and refrigeration men were attracted to Chicago during the week of January 15-19 by five conventions and all-industry exhibition. Over 300 of this number were American Society of Refrigerating Engineers members and guests who had convened to observe the society's 35th anniversary and to attend their annual convention. Over 500 were members of the Refrigeration Service Engineers Society which held its 6th annual convention. Among the others were members of the Refrigeration Equipment Manufacturers Association, National Refrigeration Supply Jobbers Association and the National Air Conditioning Association. All of these people visited, at least once, the second All-Industry Refrigeration and Air Conditioning exhibition, which showed a total attendance of 27,764. The actual registration of 7542 persons was approximately 25% greater than the registered attendance of last year's show.

Exhibitions at this show featured principally refrigeration and summer type air conditioning equipment, although there were a number of year-round and winter air conditioning products also on display.

The American Society of Refrigerating Engineers' convention was held on Wednesday to Friday and featured technical sessions dealing with industrial refrigeration, small refrigerating systems, corrosion, agricultural research, and foods. Abstracts of some of these papers appear at the end of this report.

On Thursday afternoon the society held their 35th anniversary ceremony and inducted J. F. Nickerson as an honorary member. At this session David L. Fisk reported on refrigeration in 1904 while S. C. Bloom predicted what refrigeration would be like in 1954.

The new officers elected include George E. Hulse as president, Charles Lichtenberg and L. Logan Lewis as vice presidents, William R. Hainsworth as treasurer and as directors, J. G. Bergdoll, D. F. Fisher, H. C. Guild, S. R. Lewis and Nels Rosberg.

The Refrigeration Service Engineers Society's 6th annual meeting heard on the opening day J. S. Forbes, president of the Refrigeration Equipment Manufacturers Association discuss the need for cooperation among business men. The technical program of this society was devoted to papers on proper oil charge for commercial systems, dehydration of refrigeration equipment, preservation of meat products, engineered air distribution, pressure drop in liquid lines and bomb method of charging refrigeration units. These last two papers were presented at a joint meeting of the American Society of Refrigerating Engineers and the Refrigeration Service Engineers Society, which was held Wednesday afternoon. Abstracts of some of these papers appear later in this report.

The new officers of this association include Gordon

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at Chicago

as reported by JOSEPH F. KERN, JR.

A. Burns, Toronto, Canada, as president; E. A. Plesskott, St. Louis, 1st vice president; C. Boschkopf, Beaver Dam, Wisconsin, 2nd vice president and S. A. Leitner, Kansas City, as treasurer.

A meeting of the charter members of the National Air Conditioning Association elected the following officers: Jesse W. Page, Charlotte, N. C., president, J. N. Spreklemeyer of Fort Worth, Texas as vice president, John H. Keller, Detroit, Mich., treasurer, A. L. Maillard, Kansas City, Mo., executive secretary.

The organization also adopted at this meeting a constitution which stated that "the purpose of the association shall be to advance a sound development in the air conditioning industry in the interest of public service." Two types of members are provided for, full members and associates. The constitution defines members as "those who are actively engaged in the sale and servicing of air conditioning equipment," while associate members are "those who are affiliated with the air conditioning industry." Prior to this meeting charter membership applications were received from approximately 30 men.

The National Refrigeration Supply Jobbers Association, at their annual meeting, elected F. H. Langsenkamp, Jr., of Indianapolis as new president; C. E. Borden, Boston, vice president, and Ralph Kramer, Chicago, secretary.

Leo H. Gorton, the retiring president, pointed out that the membership exceeded 100 during the year and at the present time there are 152 individual locations of stores belonging to the association's members. Abstracts of some of the papers follow:

FOODS

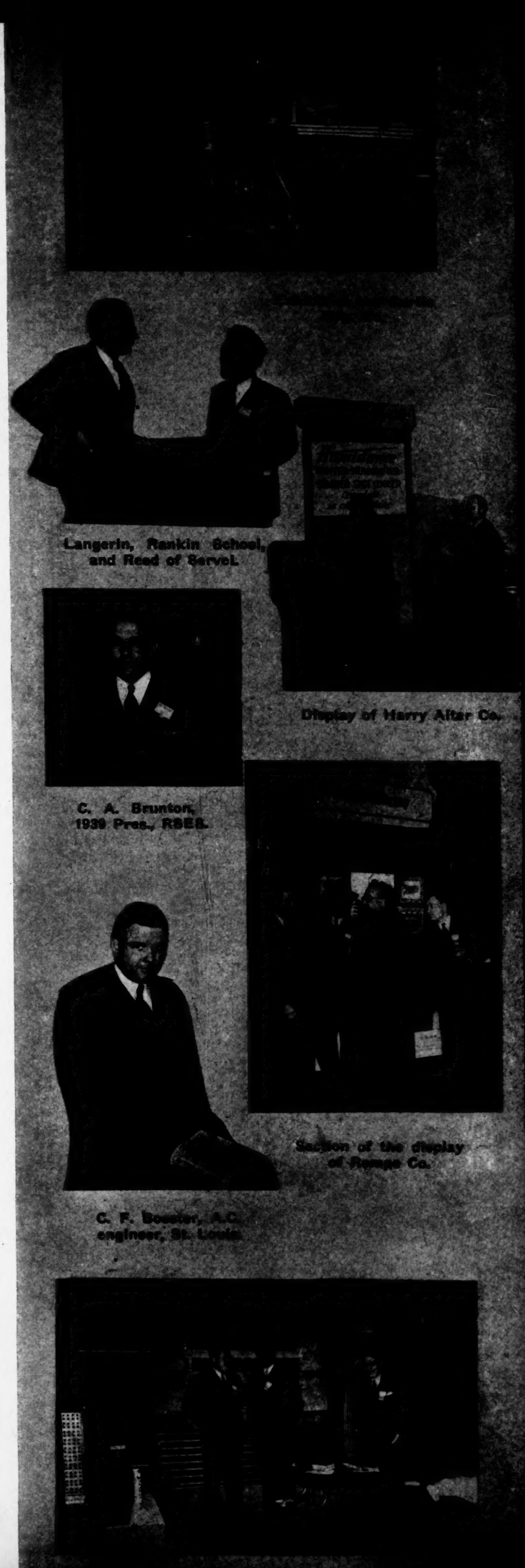
Air Conditioning as Applied to Foods and Industry, by Harry Boyd Matzen.—ASRE Paper.

Why has air conditioning and refrigeration played such a large part in the food industry? Simply because foods are products of nature, ever subject to chemical, physical and biological changes, that may be either hastened or retarded by temperature, relative humidity, air motion and/or air purity. More recently much study has also been made as to the effects of light and electrical radiation on foods.

The functions that air conditioning performs may be stated as:

1. The control of physical properties.
2. The control of chemical properties.
3. The control of biological properties.

There have been between 300 and 500 applications of air conditioning for foods and industrial processes. Applications to the food industry and industrial processing are constantly growing in number and represent a tremendous field of opportunity in the control of mass production, to produce uniform products at uniform rates of time and at low cost. Compared to "comfort" air conditioning the problems involved are far more complex.



Langerin, Rankin School, and Read of Servel.

Display of Harry Alter Co.

C. A. Brunton, 1939 Pres., RSES.

Section of the display of Remco Co.

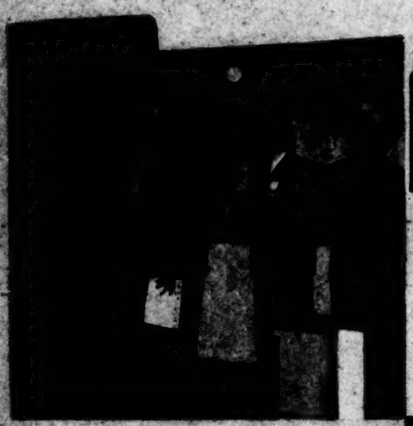
C. F. Boester, A.C. engineer, St. Louis.

Display of Automatic Products Co.

J. F. Nickerson, honorary member ASRE.

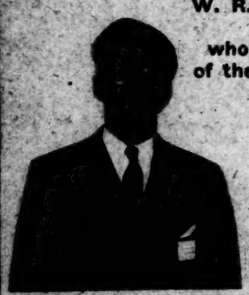
H. T. McDermott, secretary RSES.

C. V. Gary (above) sales manager, Henry Co.



(Left) Mercoid booth.

(Right) W. R. Hainesworth, Servel, who was chairman of the conference on corrosion.



(Left) D. E. Perham, Chicago Masters Steam Fitting Ass'n.

CONDENSERS

Application of Heat Transfer Data to Practical Design of Horizontal Shell Type Refrigerant Condensers, by Henry B. Pownall.—ASRE Paper.

The acceptance of Freon-12 as a refrigerant, and the increased popularity of condensing units, large and small, have played a major part in condenser design during the past few years. Formerly considerable research was done on heat transfer coefficients in condensers, but their application was largely empirical. The practice was to establish a fixed number of square feet per ton of refrigeration, regardless of other influencing factors. The advent of the condensing unit on a large production scale required engineers to study the condenser more closely.

This paper presents one method of analyzing condenser performance.

From the author's analyses the following rules are suggested for general condenser design:

1. Fixed unit areas cannot be determined for all types of surface, but the loading should be a function of the type used.
2. To obtain best condenser performance, use as high a water pressure drop as can economically be justified.
3. Terminal difference should be selected on the part of the curve in which an error in the computation of heat transfer values, or a reduction caused by scaling, will have the minimum effect.

PIPE SIZING

Pressure Drop in Refrigerant Liquid Lines, by E. Gygax and Karl S. Willson.—ASRE and RSES Paper.

Data for pressure drop in liquid lines have been the subject of various articles, but the data have been complicated and difficult to use in general and have been largely based on arbitrary pressure drop limits, allowable velocity, etc. Further, no published work, coming to the attention of the authors, has contained a systematic consideration of the effect of oil on pressure drop.

In view of this situation it was believed that actual experimental tests covering frictional pressure drop in various pipe sizes for different tonnages would be of value to the industry.

In the first place, since oils are extremely viscous as compared to refrigerants, it is apparent that a refrigerant-oil mixture will show a greater pressure drop than will the pure refrigerant. While it may not be exactly true for all types of mixtures, it is evident from the data here presented that satisfactory calculations may be made by assuming that the viscosity of the oil and refrigerant are additive, an assumption which has received backing both experimentally and theoretically for other types of mixtures. Whether viscosities are additive by weight or volume of the components is debatable. For methyl chloride-oil mixtures, it is imma-

terial since specific gravities are the same. For Freon-12 viscosity was calculated as being additive by weight. By volume, viscosity would be slightly higher, pressure drop slightly higher.

In addition to altering the viscosity of the refrigerant, introduction of oil involves two other factors. First it changes the volume circulated and second the refrigerating effect of the mixture circulated is less per pound than for pure refrigerant.

Although all test runs reported were made with 90° liquid, 40° evaporation, 65° superheated gas, and 500 Saybolt viscosity oil, it is interesting to consider the effect of varying these conditions, and it seems probable that pressure drop under varying conditions could be predicted with reasonable accuracy.

For a change in evaporator temperature of 20°, calculations show that the refrigerating effect will vary less than 1 per cent for methyl chloride and only slightly more for Freon-12, and the variation in pressure drop will be less than 1 to 2 per cent, provided the same oil is used.

AIR DISTRIBUTION

Engineered Air Distribution for Cooling, by D. J. Stewart.—RSES Paper.

Unsatisfactory distribution of cooled air has been the cause of many serious complaints and considerable antagonism to air conditioning in general.

Some of the blame for this condition must be borne by the persons responsible for the selection of the grille or other type of outlet. However, until recently there have been available no performance data which would enable an engineer to make the proper selection. The best he could do was to rely upon his experience with installations in a somewhat comparable situation.

A testing program was undertaken and has been completed. Based on these tests, sufficient data were obtained to enable the publication of a year ago of recommendations for ceiling heights up to 12 ft., room lengths up to 50 ft., air volumes to approximately 1000 c.f.m. under most conditions, and velocities up to 1400 f.p.m. Since that time the work has been extended to include much higher ceilings, room lengths up to 100 ft., air volumes up to approximately 3000 c.f.m., and velocities as high as 2600 f.p.m.

LUBRICATION

Proper Oil Charge for Methyl and Freon-12 Systems, by P. B. Reed.—RSES Paper.

If it were practical to design a refrigeration compressor in such a way that no oil ever left the compressor, the determination of the amount of oil in a refrigerating system would be simple, as the correct charge of oil could be put in by the compressor manufacturer and that amount would be sufficient, no matter what type of application the compressor would be used on. Unfortunately, this is not practical as the oil serves a useful purpose in sealing discharge and suction valves

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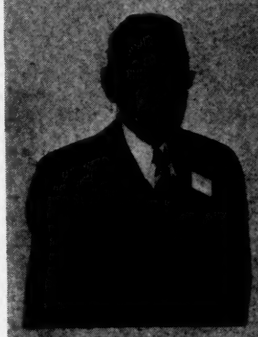
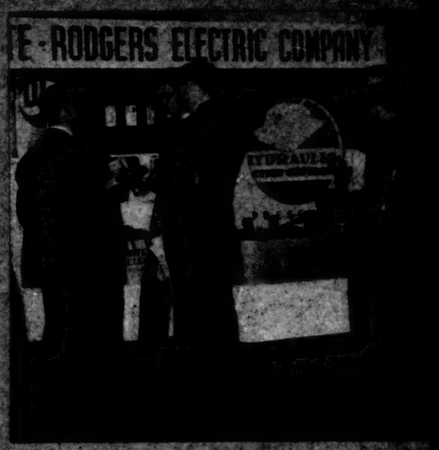


G. E. Hulse, new ASRE president.



(Right) White-Rodgers booth.

Officers of the National Air Conditioning Ass'n. (L to R) Spreklemeyer, V. Pres., Page, Pres., Keller, Treas., and Mallard, Sec'y.

A. B. Schellenberg, Pres. Alco Valve.

(Left) V. M. Lathrop, Barber-Colman, addressing RSES on air distribution.

Display of the Spoehrer-Lange Co.

Zoll of Chicago-Wilcox and Knight of Peerless.

J. R. Eckley, Aluminum Corp., and G. L. Simpson, V. Pres., Pittsburgh Lectrodryer Corp.

Anamostat Corp. booth.

(Right) One of the contestants, championship tube bending contest.

as well as lubricating frictional parts of the compressor.

How are we to determine how much oil to add to the compressor to replace the oil that leaves the compressor and is "enroute" through the condenser, receiver, liquid line, evaporator, suction line, refrigerant controls, heat exchangers, sumps, etc.? Obviously, the answer is to add oil to the compressor until its level is brought back to the height the manufacturer has found best for successful lubrication. After the condensing unit is first installed the compressor oil level will gradually become lower so that after an hour or two hours operation there will be a perceptible loss of oil from the crankcase and oil should be added to bring the oil level in the crankcase back up to normal. After this the rate of loss of oil from the crankcase will be much slower but will continue until the percentage of oil in solution in the refrigerant has become stabilized. This usually occurs within twenty-four hours and if the oil level in the compressor is then checked and oil added as necessary, it is reasonably certain that the oil level in the crankcase will (exclusive of leakage) vary but little from then on.

MOTORS

Squirrel Cage Motors for Air Conditioning and Commercial Refrigeration, by C. C. Leader.—ASRE Paper.

Since a large number of air conditioning installations are made in sections of cities where the power distribution system combines light and power service, some power companies have found it necessary to place limitations on the locked rotor currents of motors used in these areas. These power companies, however, as well as the air conditioning equipment and motor manufacturers, are vitally interested in promoting the sale and use of electrical equipment.

The restriction of locked rotor currents below the values that can be obtained with the best design practice for the double squirrel cage motor will encroach upon the torque margins found necessary for the satisfactory operation of this type of motor, or will greatly increase its cost, or both. Such restrictions will force the use of equipment that is considerably more expensive, inherently more complicated, and often more subject to trouble or failure.

Standard practice should continue to dictate the use of motors conforming to NEMA Standards for Class A, B, and C motors wherever possible. For the special cases, however, general adoption by the power companies of a minimum starting current limitation which permits the use of the double squirrel cage motor with locked rotor currents of from 350 to 400 per cent is a logical step when all these factors affecting the design, application, and sale of motors are considered. The expenditures that the power companies may have to make to permit such installations in marginal cases, should, in general, be justified by the increased business and improved customer's relations resulting from the economical solution of a troublesome problem.

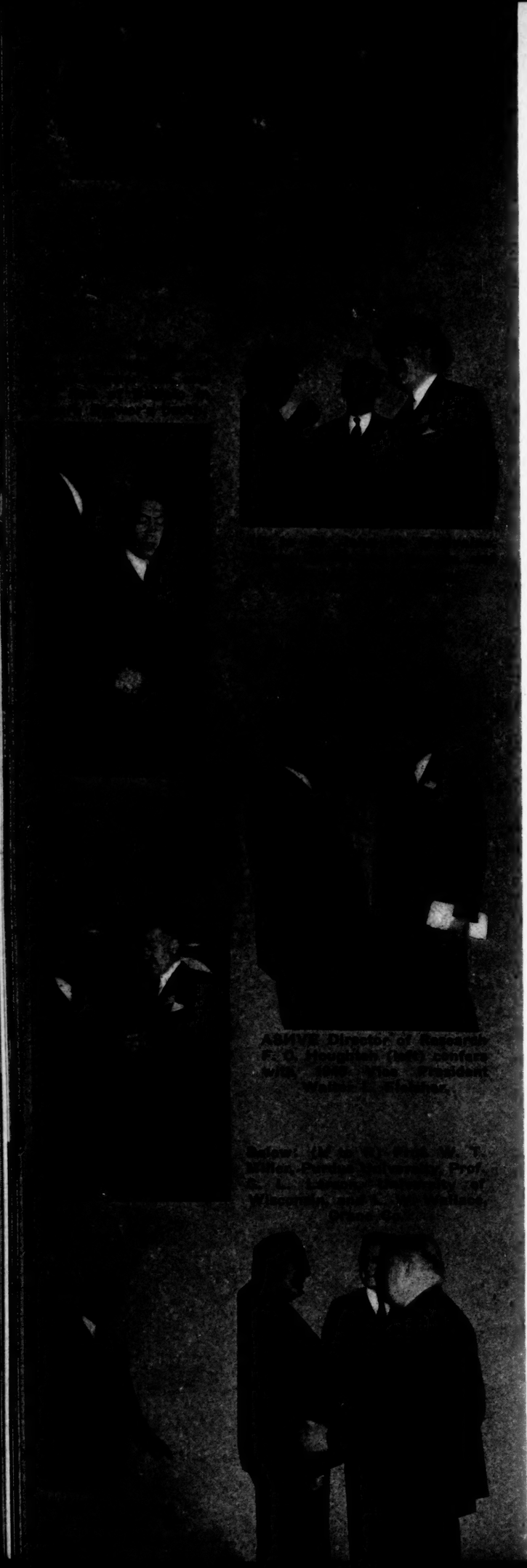
CLEVELAND . . .

was the focal point of attention for all heating and air conditioning men during the week of January 22-26, when this city was host to the 1961 International Heating and Ventilating Exposition, the 40th annual meeting of the American Society of Heating and Ventilating Engineers and the 44th annual convention of the National Warm Air Heating and Air Conditioning Association.

J. F. Montire, Detroit, retiring president of the American Society of Heating and Ventilating Engineers.

Clarence A. Olsen, Elyria, Ohio, new president of the National Warm Air Heating and Air Conditioning Association.

F. E. Giesecke, College Station, Texas, new president of the American Society of Heating and Ventilating Engineers.



. . Here Is What Happened

WITH conventions of two major organizations in the industry and with one of the largest of the six heating and ventilating expositions ever held, Cleveland was the focus of attention of all heating, ventilating and air conditioning men during the week of January 22-26. Nearly 1100 were registered at the 46th annual meeting of the American Society of Heating & Ventilating Engineers, held at the Hotel Statler, while 700 furnace and accessory manufacturers and dealers registered for the 44th convention of the National Warm Air Heating and Air Conditioning Association at the Hotel Hollenden. The Sixth International Heating & Ventilating Exposition at Lakeside Hall drew 24,476 to view over 300 elaborate and comprehensive exhibits.

The drawing power of the show and conventions was indicated by the number of those attending who came far across the country. Many attending came from Texas and California; the thousandth man to register at the ASHVE was from Los Angeles. The Western New York (Buffalo) chapter of the ASHVE, headed by Cecil W. Farrar, came to Cleveland in a special car with diner to solicit the convention for 1942. Many of those attending came to Cleveland by air.

The 44th convention of the National Warm Air Heating and Air Conditioning Association was one of the most successful in years. The convention formally opened on January 23 with L. R. Taylor as chairman. The speakers at that session included Charles M. White of Cleveland, who spoke on "The Interdependence of Industry"; C. Ackerson, Gadsden, Alabama, whose subject was "Don't Overlook the Gravity Furnace," and C. T. Burg, Cleveland, whose inspirational address on "The Three Bogeymen" was a subject of comment throughout the convention.

On the afternoon of the 23rd, F. G. Sedgwick, chairman of the research advisory committee, presented his report, while Prof. A. P. Kratz of the University of Illinois spoke on "Heat Insulation" and Prof. S. Konzo, also of the University of Illinois, talked on "Resistance of Air Flow to Registers and Grilles."

On the morning of January 24, B. F. McLouth spoke on "Our Installation Codes" and J. H. Van Alsberg presented a paper on "Sizing Registers for Forced Air and Air Conditioning Installations." F. E. Mehrings headed an "Advertising and Merchandising Clinic" while Jan S. Irvine spoke on "Our Over-All Merchandising Interest." Prof. L. G. Miller, Michigan State College, discussed the "9th Annual Short Course."

The session of Wednesday afternoon, January 24, was a joint one with the ASHVE, at which President McIntire of the Society and President Taylor presided. Walter L. Fleisher described the research activities of the ASHVE and Frank L. Meyer, Peoria, covered the research work carried on by the Warm Air Heating Association. A paper on "Performance of Stoker-Fired Warm Air Furnace as Affected by Burning Rate and

Map of Cleveland on preceding page copyrighted by The Montcastle Map Co.

at Cleveland

as reported by CLIFFORD STROCK

Feed Rate," by Professors Kratz and Konzo, was presented at this session.

Clarence A. Olsen was elected president of the association for 1940, while H. S. Sharp is the new first vice-president and Shirley Percival second vice-president.

In his first formal speech as president, Mr. Olsen declared that research and public education formed the backbone of the association and were its principal reason for its existence.

Many organizations took advantage of the presence of their members at the show and conventions by holding their meetings at various times during the week. The Industrial Unit Heater Association held its annual meeting and elected C. C. Cheyney president; Albert J. Nesbitt vice-president, and L. O. Monroe secretary-treasurer for the ensuing year.

The Institute of Boiler and Radiator Manufacturers held a meeting in Cleveland, as did the manufacturers of propeller fans and furnace blowers.

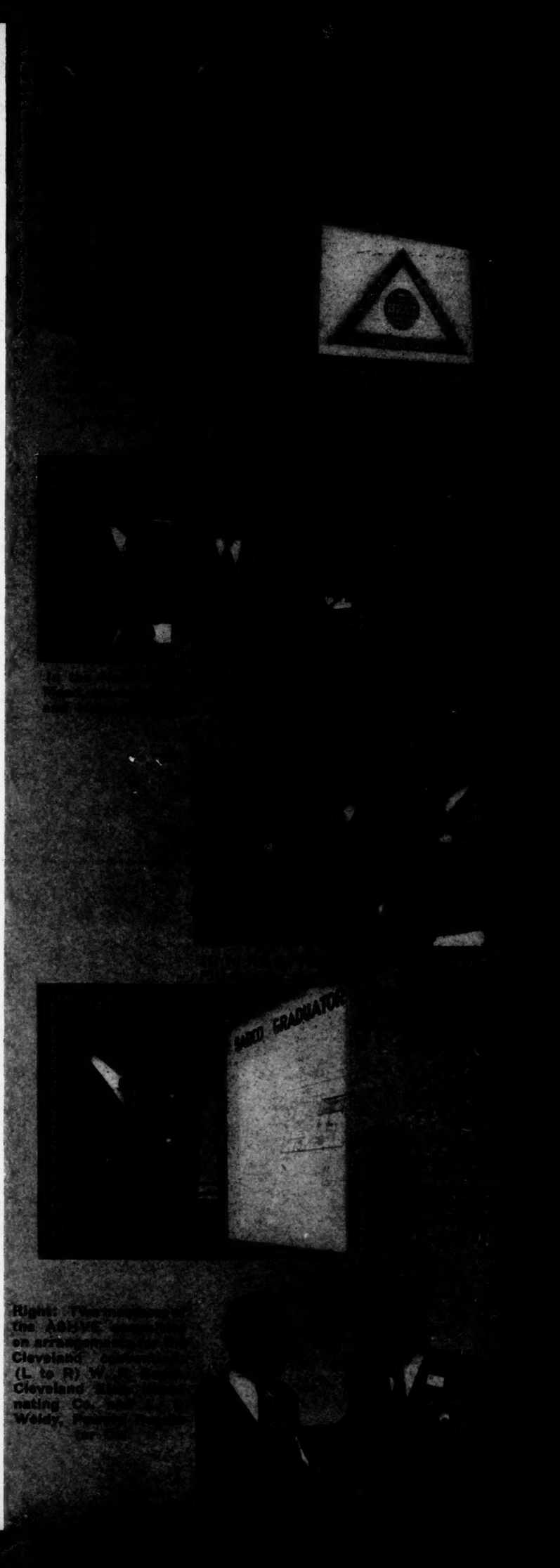
Sponsored by Oil Burner Institute a conference of oil burner manufacturers was held January 24. The purpose of the conference was to discuss mutual problems. Actually the conference spent most of the time discussing the commercial standards for oil burners and a brief period was devoted to legislation. Robert K. Thulman, FHA Mechanical Engineer, who is a consumer member of the standing committee on standards, suggested that a system of check testing be developed by Underwriters' Laboratories.

A resolution was passed calling upon OBI to formulate a check testing program. Another resolution made it clear that financial responsibility for carelessness on the part of a dealer should not be assumed by a manufacturer; this latter in reference to a recommendation that a certification of the dealer be required by the manufacturer and that the commercial standards be amended to provide for this certification.

At the annual banquet of the ASHVE Wednesday evening, Walter Klie of The Smith & Oby Co., Cleveland, presided as toastmaster. Presentation of the past president's medal to J. F. McIntire was made by Wm. H. Driscoll. Dr. F. E. Giesecke was presented to the audience as the incoming president. Dr. W. E. Wickenden, president of Case School of Applied Science, Cleveland, introduced the principal speaker of the evening, Dr. Harvey N. Davis, president of Stevens Institute of Technology, who spoke on "The Engineer's Job Today."

New officers elected by the ASHVE are: president, F. E. Giesecke of Texas Agricultural and Mechanical College of Texas; first vice-president, Walter L. Fleisher, Air and Refrigeration, New York; second vice-president, E. O. Eastwood, University of Washington; treasurer, M. F. Blankin, Haynes Selling Co., Philadelphia.

According to the report of the ASHVE committee on research, an agreement was consummated during 1939 with the U. S. Navy for conducting a comprehensive cooperative research program. Another project



Right: [illegible] the ASHVE [illegible] on arrangements [illegible] Cleveland [illegible] (L to R) W. [illegible] Cleveland [illegible] nating Co. [illegible] Welsh, [illegible]

Left: (L to R) W. F. Friend, Ebasco Services Inc., New York, and John de B. Shepard, Consolidated Gas Electric Light & Power Co. of Baltimore.

Prof. Axel Marin, University of Michigan, ASHVE past president W. T. Jones, Boston, and Prof. Clark M. Humphreys, Carnegie Tech.

A. E. Stacey, Jr., new Chairman of the ASHVE Committee on Research, and C. A. Booth, vice president of Buffalo Forge Co.

which was initiated was a study of radiation for practical comfort.

A. E. Stacey, Jr., of Buensod-Stacey, Inc., New York, was elected chairman of the committee of research for 1940.

Summaries of the technical papers presented at the ASHVE meetings follow:

GLASS BLOCKS

Heat Gain Through Glass Blocks by Solar Radiation and Transmittance, by F. C. Houghten, David Shore, H. T. Olson and Burt Gunst.

This paper is the result of a test conducted by the ASHVE research laboratory to make available acceptable design data on heat gain through glass block construction. The authors presented a series of curves showing the heat transmission for walls facing in different directions based on their own work together with curves based on tests by other organizations. The report is not conclusive, inasmuch as the tests were conducted for a period of only one summer and further tests will be run before the final report is published.

STOKERS

Performance of a Stoker-Fired Warm-Air Furnace as Affected by Burning Rate and Feed Rate, by A. P. Kratz and S. Konzo.

Using a high volatile bituminous coal, the authors have conducted extensive tests on stoker firing of furnaces at the Research Residence of the University of Illinois. Their conclusions, which follow, may be considered as applying to the Research Residence and the conditions under which the tests were conducted.

1. The burning rate in the case of a stoker-fired furnace is not necessarily determined by the rate of coal being fed to the furnace, but rather by the rate at which the air is supplied to the fuel bed.

2. In the case of a domestic underfeed stoker, the air supplied to the fuel bed through the tuyeres is utilized for both primary and secondary combustion.

3. With a constant air supply to the fuel bed, the burning rate increases progressively during long on-periods of the stoker.

4. Any combustion occurring in the off-periods reduces the surplus coal fired into the fuel bed, with the result that the thickness of the fuel bed tends to remain constant, even though the feed rate is considerably in excess of the burning rate.

5. With a freely burning coal that does not coke strongly, a feed rate only slightly in excess of the burning rate results in a thinner fuel bed and a greater fuel consumption than those obtained with a feed rate considerably in excess of the burning rate.

6. The amount of smoke obtained during the off-periods may limit the amount that the feed rate can be in excess of the burning rate.

7. An intermittently operated stoker in a forced-air

heating plant is extremely flexible, and a wide range of adjustments in the air rate and feed rate will give acceptable combustion conditions.

EVAPORATION

Dynamic and Thermal Behavior of Water Drops in Evaporative Cooling Processes, by H. B. Nottage and L. M. K. Boelter.

Effective design and operation of spray nozzles require simple construction yielding a high effectiveness of energy conversion, with liquid particles of the proper size distributed throughout the reaction chamber. The behavior of drops may be predicted from the results presented in this paper.

The ultimate goal of these researches, cooperative between the ASHVE and the University of California, is to present data which will allow the execution of a penetrating design of heat and material transfer equipment in terms of the predicted behavior of the small but discrete component systems whose superimposed behavior ultimately governs the macroscopic performance of the complete unit.

INSULATION

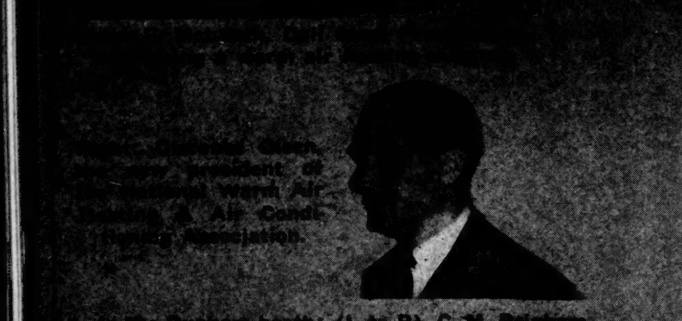
Effect of diminishing Return on the Value of Insulating Materials, by Paul D. Close.

According to the author, technical secretary of the Insulation Board Institute, because of diminishing return, the first increment of thickness of insulation is the most effective and each successive increment of thickness is less and less effective. The rate of diminishing return, however, depends on the initial wall or roof coefficient and the point at which the curve begins to flatten out or become asymptotic ranges from about 1 in. of insulation for a 0.20 (B.t.u. per sq. ft. per deg. per hour) wall or roof to about 2 in. of insulation for a 0.80 wall or roof.

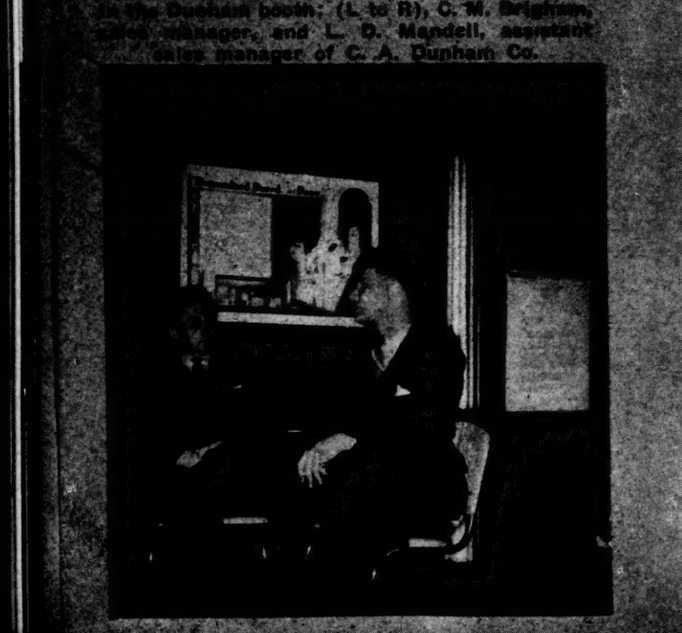
Thus this range of thickness—1 in. to 2 in. or an average of 1½ in.—may be regarded as the limit of maximum effectiveness, beyond which the effective value of the insulation is extremely limited.

The first 1-in. of insulation added to a 0.30 wall or roof will reduce the heat loss through the wall or roof to the extent of 47.5% for the conditions under consideration. The next 3 in. will reduce the heat loss an additional 33.0%. Therefore, this next 3 in. are only 69.5% as effective as the first 1 in. of insulation. Because of the rapidly diminishing return it would actually require 20 in. of insulation in this case to produce the same results as the first 1 in. of insulation.

When wood sheathing and lath are replaced with 25/32-in. insulating board sheathing and ½-in. insulating board lath, the heat loss through the wall is reduced 42.3%. If 1-in. lath is used in place of ½-in. there would be an additional saving considering the walls only, of 11.0% and the combined saving would be 53.3%. The next ½ in. of insulation would save



In the Dunham booth: (L. to R), C. M. Brigham, sales manager, and L. D. Mandell, assistant sales manager of C. A. Dunham Co.



7.3%, the next 5.3%, the next 4.0%, the next 3.4%, the next 2.5%.

Similar results were obtained when the law of diminishing return was applied to the total heat losses of a residence. Insulating board used throughout showed a saving of 33.4% whereas the maximum saving obtained by the use of wall-thick materials was only 4.2% greater, or 37.7%. By distributing the insulation over all wall, roof and glass surfaces, using insulating board in combination with storm windows and weatherstrips, instead of concentrating the insulation in the wall and roof areas, the total saving was increased to nearly 50%, as compared to the uninsulated building.

FILTERS

The Effect of Lint on Air Filter Performance, by Frank B. Rowley and Richard C. Jordan.

The conclusions which may be drawn from the investigation reported by the authors and carried on at the University of Minnesota, are as follows:

Lint in the air contains both short and long fibers, the greatest percentage by number being the short fibers, but the greatest percentage in weight being the long fibers. From the tests made it appears that the dust-lint mixture made up entirely of long fibers affects the filter performance characteristics in substantially the same manner as a similar dust-lint mixture made up of short and long fibers of the same ratio as found in lint removed from filters. For this reason the long fibers which are more easily prepared should be satisfactory for the comparative rating of filters.

Lint in air has a dominating influence on the life and dust holding capacity of some filters. With three of the four filters tested the addition of 10% by weight of long fiber lint to the test mixture reduced the life to less than 20% of that determined with no lint in the mixture. Additional lint up to 20% showed relatively little further reduction in life.

Lint in air tends to increase the arrestance of most air filters slightly. With all filters tested increasing percentages of lint by weight resulted in increasing arrestances, partly due to the increased dust eliminating efficiency of the media when containing lint deposits, and partly due to the fact that the filters were practically 100% efficient in removing lint.

The effect of lint on the performance characteristics of filters appears to be greater for that type in which the filter capacity depends upon the distribution of dust throughout its depth. For this type of filter the effect of lint is increased when some section is of such construction as to trap the lint and cause abnormally high localized pressure drops.

Since in practice many filters are called upon to eliminate rather large percentages of lint from the air, and since lint in the air has a dominating influence upon the filter performance characteristics, lint should be considered as an element in the standard dust used for rating air filters.

BACTERICIDE

Advantages of Bactericidal Ultraviolet Radiation in Air Conditioning Systems, by Harvey C. Rentschler and Rudolph Nagy.

The authors, both of the research laboratories of Westinghouse Electric & Mfg. Co., point out that:

1. The use of ultraviolet radiation in air conditioning ducts has been found to be commercially practical.
2. There is no difference in the bactericidal effect of ultraviolet over a range of relative humidity between 35 and 95%.
3. There is no difference in the bactericidal effect of ultraviolet radiation over the normal range of temperature usually found in air conditioning systems.
4. Calculations and curves have been prepared and checked by tests on a practical installation so that the number of lamps required for any given volume of air can be readily estimated.
5. For bacteria with greater resistivity to ultraviolet radiation than B. coli the intensity of radiation must be increased proportionately.
6. The use of ultraviolet radiation for destroying bacteria, when properly applied, has the advantage over other bactericides in that nothing is added or removed from the air.

HEAT EXHAUSTION

The Peripheral Type of Circulatory Failure in Experimental Heat Exhaustion—The Role of Posture, by Robert W. Keeton, Ford K. Hick, Nathaniel Glickman and M. M. Montgomery.

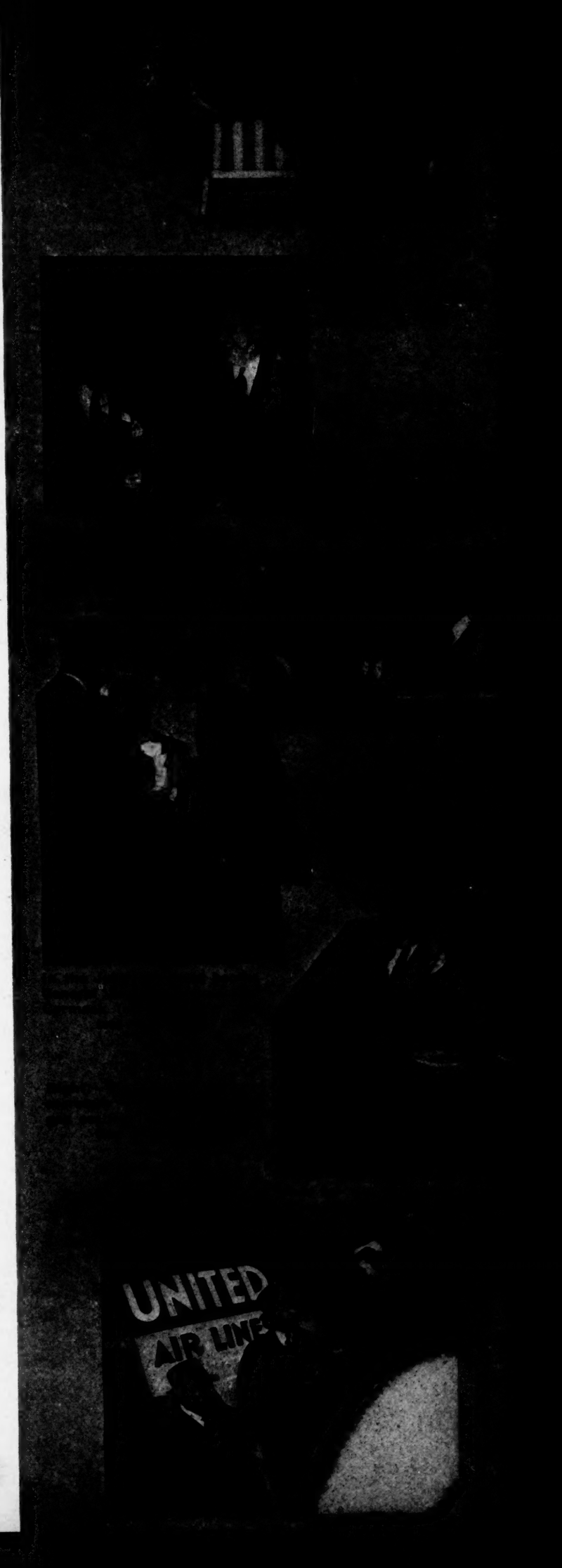
The authors, all of the University of Illinois, previously reported on the effects of exposure of healthy human beings to comfortable, hot dry, and hot wet conditions. In this paper they deal with the strain on circulation of exposure to conditions which cause heat strokes. They conclude that:

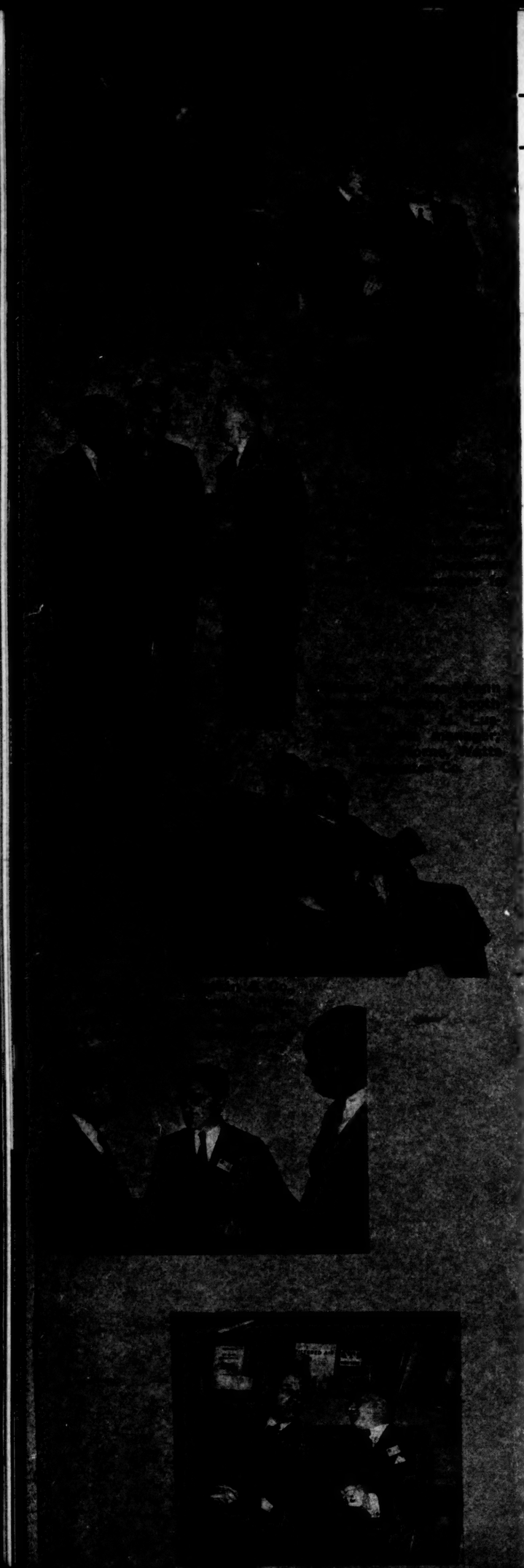
1. Circulation is well maintained in hot environments by healthy subjects while they are lying down, as is shown by normal arterial and venous pressures.
2. Adjustment of the circulation to the erect position becomes increasingly difficult for normals as the environment becomes hotter and fever appears.
3. Failure of this adjustment to the erect posture leads to symptoms of faintness or fainting, and constitutes, in the opinion of the authors, the clinical result known as heat exhaustion.

COILS

Calculation of Coil Surface Areas for Air Cooling and Dehumidification, by John McElgin and D. C. Wiley.

The purpose of the authors, both research engineers with John J. Nesbitt, Inc., is to develop a convenient method for computing the area of fin and tube surface needed for simultaneous cooling and dehumidifying. In this paper they presented a surface temperature chart which permits the direct determination of surface temperature from the air wet-bulb temperature,





the refrigerant temperature, and the coil characteristic. A method is presented for the graphical determination on the surface temperature chart of the air and refrigerant conditions at the point where dehumidification begins.

The logarithmic mean total heat difference is derived as the potential causing heat flow from warm moist air to cold wetted surface. The relation between total heat at saturation and temperature is investigated. Equations are presented for computing the amount of surface required to cool and dehumidify air to specified conditions of total heat.

DUCT FRICTION

Analysis of the Factors Affecting Duct Friction, by J. B. Schmieler, F. C. Houghten and H. T. Olson.

In this paper, reporting results of work at the Society's Research Laboratory, the authors have expanded the field covered by their previous work.

Analysis of the test data of the authors indicates a value of 1.83 as the exponent of the velocity in the friction loss formula which fits the test data best. The velocity exponent of 2 which has been generally accepted and used by many engineers does not fall within the entire range of the test data.

Calculated pressure losses both for duct with no joints and duct with 40 joints per 100 ft. using the friction loss formulas developed in this paper, check test data to a high degree of accuracy. The close agreement between theoretical and experimental results shown for the wide range of velocities and duct sizes studied serves to lend confidence to the acceptance of these formulae in calculating pressure losses for smaller, intermediate, and larger sizes of duct. The formula for friction loss proposed would then be

$$H = \frac{1.47\ (V/4000)^{1.83}}{D^{1.30}}$$

INSULATION

Thermal Test Coefficients of Aluminum Insulation for Buildings, by Gordon B. Wilkes, F. G. Hechler, and E. R. Queers.

In this paper, by members of the staffs of Massachusetts Institute of Technology and The Pennsylvania State College, the authors review previous work on aluminum insulation and report results from new tests. Their conclusions follow:

1. When the roof tests were made in the various positions, one test of each application of insulation was made in a vertical position. Excellent agreement was obtained in the results by the two different methods of test. These values confirm the reliability of the guard plate calorimeter as a method of making heat transmission tests and establish the validity of the results obtained by two independent methods.

2. It should be noted that the results of these tests again confirm the fact that the conductance of an air space faced with a reflective surface varies with the

temperature difference and, as shown in these experiments, there appears to be no relation with mean temperature. In the case of reflective insulation the principal mode of heat transfer is by convection and only a small amount is transferred by radiation. The heat transfer by convection varies as the 5/4 power of the temperature difference. Consequently, the smaller the temperature difference the lower the conductance value of an air space containing reflective insulation. This fact is borne out by the data and in all cases the values at 25F difference are lower than those for 45F difference. The 25F difference is an extreme summer condition and the 45F is an extreme winter condition.

3. For reflective insulation orientation must be considered. An unusually low heat-transfer value is obtained with the heat flowing down. This is particularly striking in the horizontal positions. In these cases the major portion of the heat transfer is by conduction while radiation and convection are a minimum. In some instances the reflective insulated structures are vented for summer conditions. However, the vents should be closed for the heating season.

4. Insulation is usually added to a structure to obtain fuel savings and produce comfort to the occupants of the building. The comfort factor is more important in the summer than winter, since most heating systems have sufficient capacity to produce comfort. Since reflective insulation performs most effectively with the heat flowing down, as it does in the summer, this insulation is particularly effective in retarding summer heat influx through roofs into top floor living quarters.

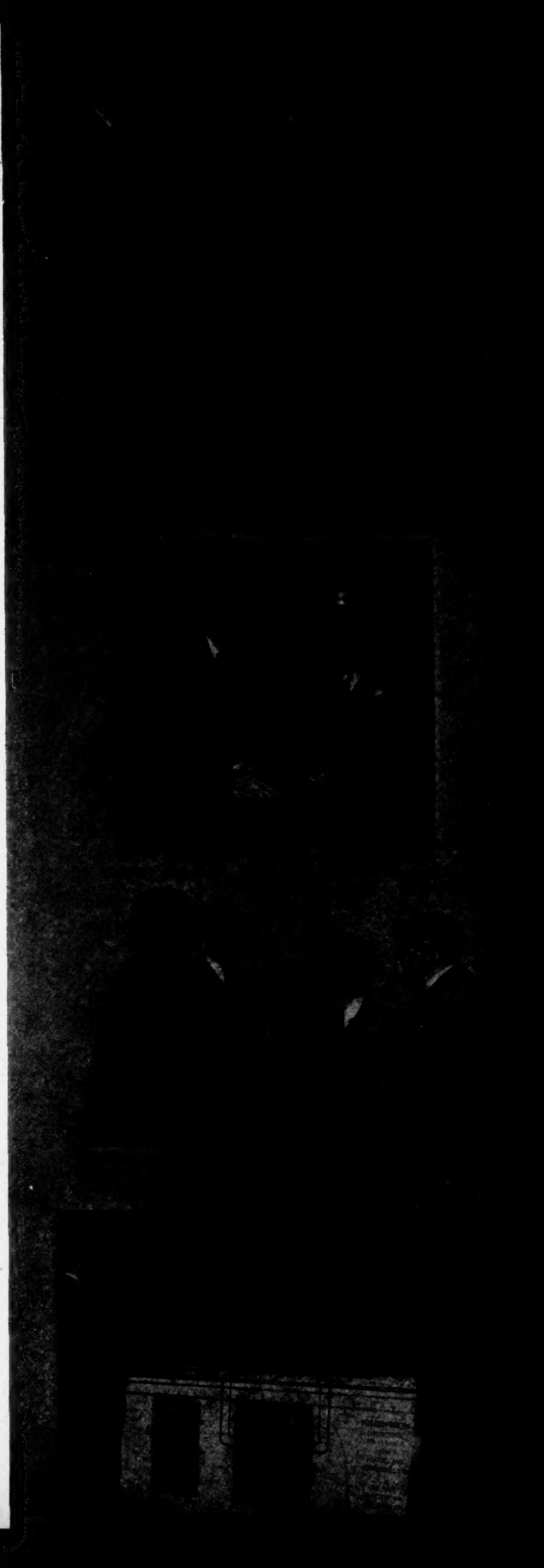
STACK HEADS

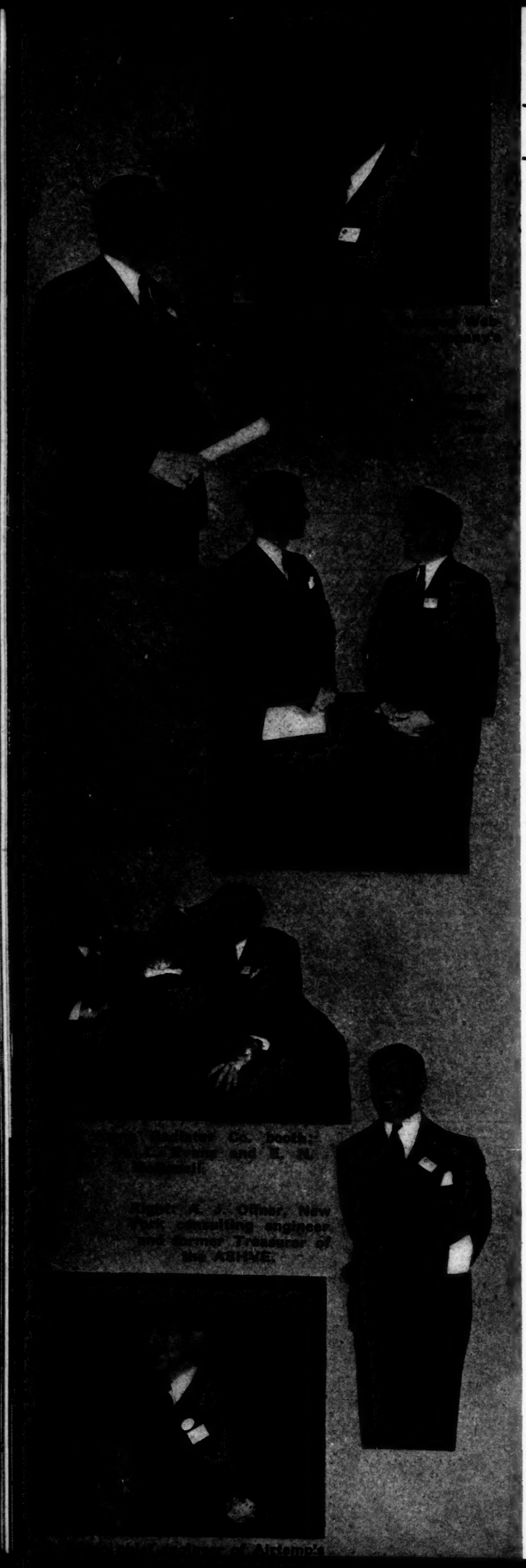
The Performance of Stack Heads, by D. W. Nelson, D. H. Krans and A. F. Tuthill.

Since the approach to a grille has a great effect on air distribution the authors studied stack head performance at the University of Wisconsin, with which they are connected. Their conclusions follow:

In most stack heads whether of the square or round type the air left at angles varying from 20 to 35 deg. with the horizontal. The angle with the horizontal was less for stack heads with square throats than for those with an inner radius. A change from a 3-in. to a 6-in. inner radius only lowered the angle slightly. A greater face to throat dimension lowered the discharge angle. A larger face opening height resulted in a greater angle of discharge. This increase with an increase in opening height from 6 in. to 9 in. was twice as large with a rounded back stack head as with a square head.

The highest pressure drop was found with the square-throated rounded-back type. The square type showed only slightly less drop. On either of these the substitution of a 3-in. inner radius for the square throat caused the pressure drop to become very much less. The use of a 6-in. inner radius resulted in a further decrease in pressure drop. Splitters in stack heads with short radii and turning vanes in square stack heads





lowered the pressure drop below that of the long radius stack head tested. Splitters in the long radius stack head reduced the pressure drop below that for the square and short radius types with turning devices.

When applied to expanding stack heads the turning devices resulted in lowering the static pressure at the base of the stack head below atmospheric pressure. This was due to the uniformly low velocity over the whole discharge area and the interchange of kinetic and pressure energies between the inlet and outlet of the stack head.

The sum of the static pressure and the velocity pressure at the base of the stack head was considered to give a measure of the energy required to make the turn and to enter the atmosphere where all energy in these two forms is dissipated. In square type stack heads the addition of turning vanes dropped this energy to about 45%, considering the energy required in the plain fitting as 100%. The application of splitters to the long radius turn reduced the energy to 90% and to 74% with the short radius turn.

The application of splitters and turning vanes improved the performance of stack heads materially.

AIR CONDITIONS

Seasonal Variation in Reactions to Hot Atmospheres, by F. C. Houghten, A. A. Rosenberg and M. B. Ferderber.

From the data presented in this paper it is indicated that a person's acclimatization to atmospheric environments during different seasons of the year not only affects his desire for some higher or lower effective temperature condition, but also affects certain physiological reactions. That is, both his body temperature rise and pulse rate increase are greater during the winter than during the summer upon being exposed to the same high indoor effective temperature for the same period of time. Moreover, the body appears to undergo a progressive change in acclimatization with change in seasons, for pulse rate increase and temperature rise data during spring show a transition period between winter and summer, the rises being greater than for summer but less than for winter. The charts presented in this paper show also that acclimatization has but little effect at the higher effective temperature in regulating body reactions, such as temperature rise and pulse increase; at some quite high effective temperature condition acclimatization would probably have no effect.

The sample curves for recovery of body temperature and leucocyte count after a subject has been relieved from a hot atmospheric condition to one of a comfortable environment indicate that the body returns quite rapidly toward normal. After one hour of recuperation, the body temperature was found to return at least to within 0.4 deg. of normal; while the leucocyte count was found to return more than halfway to its initial control room value.

Theater Steam System Operation Improved by Utilization Engineering†

By D. W. BLAIR‡

How steam utilization of the heating and air conditioning system supplied with district steam was improved by careful engineering following the installation of the system.

TO assure efficient and economical operation, the steam service connection must be designed so that steam is used only when and where needed. For this, the heating requirements should be analyzed by using a flow diagram.

In the case about to be described there are four separate heating systems, as shown in Fig. 1:

(I)—The air heating and ventilating system for the theater auditorium is used all the time the theater is open, 9 a.m. to 11 p.m., to maintain comfortable and pleasant conditions for theater patrons.

(II)—The direct radiation system in the auditorium is used to supplement (I) during severely cold weather.

(III)—The direct radiation system that heats the office building is used to maintain an inside building temperature of 70F during office hours and to prevent freezing during nights, Sundays, and holidays.

(IV)—The direct radiation system that heats the theater lobby, offices, and service rooms is used the same as (III) except that the heating hours are the same as the theater.

After going through the flow meter, the steam is supplied to the building heating systems. Steam flow to the air heating and ventilating system is turned on and off by a hand valve, but during operation is regulated by a diaphragm valve. The theater auditorium direct radiators are hand controlled with no automatic features.

An existing 150-foot pipe line, under the auditorium from the boiler room to the front of the building, is used to heat the office building and theater lobby, offices, and service rooms. An automatic valve is installed in this line and is actuated by a control of the type that is affected by outdoor and radiator temperature; the radiator temperature is varied so as to maintain a constant inside temperature regardless of the outdoor temperature. A program clock switches from day control to night control when desired; a night thermostat is used to keep the building from becoming too cold at night and on Sundays and holidays. As the office building's hours are shorter than the theater's, a hand valve is provided in the line to the office building, and is closed when desired to heat the lobby only.

Hand valves which are to be operated frequently are equipped with sprocket wheels and chains. This is important where valves are hard to reach and where ease of operation tends towards more economical operation.

One problem faced by utilization engineers on jobs like this is somewhat different from usual heating engineering in that the condensate is not returned from the heating system but is discharged to the sewer. After the steam passes through the heating systems there is still considerable heat left in the condensate. As this heat is often 10% of the total heat purchased it is very important that it be used in some way. On this particular job the heat in the condensate is salvaged in three different ways:

(1) The returns from the office building, theater office, and lobby are discharged to a large hot water type radiator in the stairwell of the office building (air heating economizer, Fig. 1). This stairway always had been a cold spot, so that additional comfort as well as economy was obtained by extracting the heat in the condensate before it goes to the sewer.

(2) The returns from the theater auditorium heating systems are discharged first through the coil of a domestic hot water heater. As the hot water service is not important, not much heat is used this way.

(3) From the water heater the theater returns are piped into the air washer tank and used as the washer water that is pumped to the air sprays. This is a particularly effective method of reclaiming the heat in the condensate. It is somewhat self-regulating as far as humidity goes, even if there are no humidity controls, because the steam and the humidity requirements usually vary directly with the coldness of the weather.

Operation of System

The second phase of engineering this job is the actual operation of the system. As is very well known, a job often works out differently in practice than on paper. Several changes and additions were made, the necessity for which became apparent during the first heating season.

The automatic control for the office building is designed to vary radiator temperature according to outside temperatures. This works well if used for 24-hour heating, but if a clock is used, as in this case, to shut off steam at night, this type of control may give trouble at the morning turn-on, due to the fact that the radiators may become hot enough to cause the control to shut off before the building is warm. To correct this a wall thermostat was installed and wired so as to be in series with the radiator control, and keeps the steam on until the building is up to temperature. This arrange-

†From a paper presented before the Boston section of the National District Heating Association.

‡Steam Heating Dept., Boston Edison Company.

ment is very flexible and provides for a wide range of heating requirements. Some other minor changes were made, such as balancing radiators, installing air vents and removing water pockets.

However, after the system had been operating for a while, records of steam consumption per degree day indicated waste somewhere. A condensate meter was installed to measure the returns from the office building and theater lobby. With this it was possible to tell how much steam was used in the office building and theater lobby and how much in the auditorium.

It was soon apparent that the auditorium was using much more steam than it should, and this led to an investigation of the air heating and ventilating system, which was installed about ten years ago for summer cooling and winter air conditioning. There is one main fan, operated at a constant speed. The system is equipped with the usual primary and secondary heating coils, air washer and a control system that, by diaphragm motors, controls dampers, steam flow valves in winter, and in summer the temperature of the refrigerant.

There were continual complaints from patrons about cold drafts in the orchestra of the theater, though at the same time the first and second balconies were unbearably hot. From appearance of the patrons there, one would think it was midsummer, although outdoor temperature would be down below freezing.

It was heartbreaking to stand in the engine room, observing operation of this system. Fresh-air dampers and by-pass dampers stuck in position, either open or closed. Controls were out of service and the fan was running at full speed. Air was entering the auditorium at temperatures from 90F to 110F, literally blowing steam and money away. Yet some of the audience was feeling cold drafts.

A great deal of excellent work is wasted if the installation of a system such as this gets a million dollars worth of engineering and the operation of it gets little, if any, engineering attention.

A survey showed: first, the fan was run at one speed only, full capacity, with no provision for speed regulation of any kind; then the controls were not used at all during the winter, and in summer they were used only to control the refrigerant temperature; therefore, the damper motors and steam flow valves were out of service. This state of affairs had existed since shortly after the equipment was installed, ten years ago. No body seemed to know just what was wrong with the controls and the cost of a motor speed control was deemed prohibitive. Estimates in the past for a motor control varied from $200 to $300.

It was obvious that this air heating and ventilating system must be placed in good working order before the steam service would be successful. Both the fan and control problems were tackled at the same time.

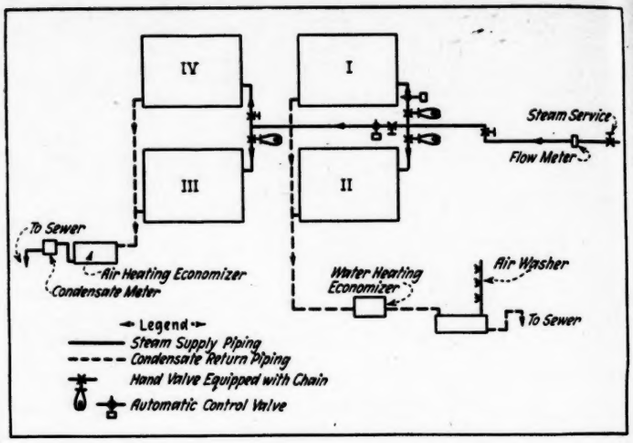


Fig. 1. Schematic diagram of the four interconnected systems.

How System Was Changed

To vary the speed of the fan, which was driven by a d-c shunt-wound motor, it was a simple matter to install a field rheostat, costing about $13, which was used to vary the field strength to increase the motor speed. Then to get the lower speed wanted in the fan itself, a smaller pulley was installed on the motor and the fan belt shortened. The pulley selected gave a low fan speed, using the same motor speed as when operating at the original constant speed, of about half the former fan speed. Then, by operating the field rheostat and speeding up the motor, the fan was run faster as desired, to meet the varying ventilation requirements of the auditorium. Total cost of this set-up was about $70. This may be considered a rather backward way of doing things, but it secured the desired results at low cost and made everybody happy.

As there were no plans of the equipment available, it was necessary to trace all the control installation, study the equipment and then make a layout to assist in showing how everything operated. After considerable work on this, it was found that a complete control system was available and that the only thing needed was servicing. Every piece of apparatus was tested and it was found that the trouble with the whole system was that the main thermostat, located in the return air duct and controlling the fresh air dampers, by-pass dampers and the steam flow valve, was out of order and not functioning. The thermostat was removed, repaired and replaced in good working shape. The automatic controls from then on did a particularly fine job of regulating the air temperature in the auditorium.

The result of all these changes has been that the patrons and tenants are now comfortable, the theater management is pleased about the better economy and efficiency of the system, and the engineer is now happy that the problems have been solved.

EDITORIALS

Profit Motive and Air Cooling

Ever since air cooling began to attract public attention the assumption seems to have been made at least tacitly that its greatest appeal would be found when used for purposes of personal comfort. The public generally seems to accept the idea that the cooling of air for personal comfort reasons as in residences, for example, would be as generally practiced as, let us say, the practice of keeping automobiles for non-commercial purposes.

Those closely connected with the industry, however, have long been aware that even though this assumption might ultimately prove to be correct, certainly the source of present business lies in the ability of the installation to pay its owner a profit. How extensively this is the case at present is well brought out by the recent compilation of statistics published by the Air Conditioning Committee of Edison Electric Institute. Analysis of the figures reported by that Committee indicates that of the upwards of 1,000,000 hp. now installed to furnish motive power for air conditioning equipment not more than 10% is in installations in places like public buildings, residences, hotels and apartments, where the owner put in the installation with no idea of making a profit for himself. In other words, at least 90% of the horsepower now used for air conditioning purposes was put in because the owner risked his money with the hope of making a profit. Up to now, if the industry had had to depend only on air conditioning put in for purely personal comfort uses the market would have been slim indeed.

This situation is one which may easily change as time passes. The mere fact that up to now the personal comfort motive has not been very weighty does not prove that it may never be so. In fact there is a good deal of reason to believe that the next big job facing the industry is to make air cooling so appealing that people will be willing to have installations made without regard to any profits which may come to them as a result of doing so. When this comes about then the use of air conditioning can be expected to become general to an extent comparable to that now enjoyed by personal automobiles and personal radios.

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New Boiler Rating Program

Announced as effective January 1 last is the inauguration of the I-B-R Rating program for small cast-iron boilers. Under this plan boiler manufacturers submit their boilers to a definite test procedure and then make the results available for scrutiny by the Institute of Boiler and Radiator Manufacturers. Once convinced that the evidence is satisfactory the Institute procedure makes it possible for any boiler manufacturer to secure a license to use the I-B-R rating and to attach a registered symbol to his product. The plan is reported to have the active support and endorsement of makers of a large part of the cast-iron boilers produced.

This latest plan for securing some degree of uniformity in ratings of cast-iron boilers starts in an atmosphere which makes it appear hopeful that full success may be realized. Moreover the plan contains features not found in any of the earlier plans for accomplishing this same general purpose and most of which met with no success. If the plan can succeed in bringing some measure of stability to boiler ratings it will not only be doing what a series of plans extending over the past 20 years has failed to do but it may also act as the greatest stabilizer of consumer confidence in cast-iron boilers. The plan gives every evidence of having been worked out in a sincere desire really to eliminate the confusion which has so long been present in connection with ratings of cast-iron boilers. It deserves the active support of all.

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More Operating Results Needed

With air cooling in such extensive use it is rather surprising that more information has not appeared to prove the results obtained. That the results have been generally acceptable, in spite of some notable exceptions, is well demonstrated by the growth in acceptance. In such form though results are not as satisfying as when some numerical data can be shown. Results stated in definite terms of added business volume obtained following installation of air cooling, or of decreases in employe illnesses or absences are the kind which are especially convincing. While a small amount of such information has appeared it is more conspicuous by its absence than by its presence.

Our own efforts to uncover this kind of data convince us that most owners of air cooling installations do not see how their interests are served by installing meters and keeping records of energy consumption, of going over their accounts to determine the increase in business, or of analyzing their labor records to learn about changes in the amount of illness of employes. Such studies are left to a few electric utility companies, to a few chain stores who expect to use their findings to guide their future policy, and to a few business managements interested in knowing the facts. More record-keeping is highly desirable. Nothing is a better aid to sales than really satisfying records from satisfied customers. Nothing helps improve future installation more than being able to point to constantly improving results. Never overlook an opportunity to gather operating results yourself. Arrange to give them publicity. Moreover, never fail to encourage owners to keep their own records. If your installation is well made, the results will be something to be proud of and something that will help your own future as well as that of air cooling. As air cooling piles up a really convincing record of what it can do its future becomes more and more firmly assured.

ABSTRACTS of Current Papers, Books and Pamphlets

Summer Weather Data

Our summer weather is extremely diversified. We have the hot, dry summer of the southwestern plateau regions, the really delightful weather of mountainous districts with their just warm enough days and their chilly, stimulating nights, and the oppressively hot, humid days and nights of the low-lying valleys and coastal plains.

Our summer weather also is the very reason why there is such a thing as artificial cooling for human comfort and is one of the important factors where this cooling is used for other purposes. A sufficiently detailed knowledge of its nature is important in planning an air cooling installation in order that sufficient capacity may be provided and in order that estimates of the cost of operation may be forecast. This book goes a long way toward permitting the weather factor to be brought into the realm of applicable engineering data.

The book is broad enough in scope to cover the subject of summer weather data rather fully. However, doubtless its greatest feature lies in the collection of pertinent weather data which it contains and which accounts for over half of its pages. Chapters are devoted to dry bulb temperature, wet bulb temperatures, dewpoint temperatures, summer winds and hours of summer sunshine. The data are presented by an extended table in each of these chapters for most of the large cities of the United States. In each case, too, the tabular information includes a statement of the number of hours in the summer period during which a variety of specified conditions are exceeded. For example, it can be found that in the city of Cleveland in a normal year the dry bulb temperature will equal or exceed 95F during 39 hours in the period from June to September inclusive on a twelve or twenty-four hour basis, and for 36 hours on an eight-hour basis. Similar figures for wet bulb temperatures are 65, 57 and 45 hours. The collection of this data is without doubt the most extensive of its kind ever published in one book and thus made available in condensed form.

Some discussion is presented indicating how the data may be applied in arriving at design conditions and in preparing estimates of operation of air cooling equipment which works against the outside weather conditions. Generally, however, it can be considered that the data as presented in tabular form speaks for itself and that the details of use can be left to the judgment of the one who is applying it.

While the material as presented leaves some obvious loopholes such as the failure to indicate the frequency or severity of simultaneous occurrence of excessive wet and dry bulb temperatures, the length of the normal cooling season in days, and in spite of the fact that a considerable part of the data are taken over a rather small number of years, still the book represents a monumental task of collection and tabulation. It is unlikely that a more detailed or more extensive study of summer weather data in the United States will appear for a long time. It makes available badly needed information and no equipment designers, installers or operators should fail to have it.

[*"Summer Weather Data," compiled and edited by J. C. Albright. Published by The Marley Company, St. Louis, Mo. Fabricoid cover; 8½ x 11 in.; 165 pages. Price, $3.*]

BRIEF REVIEWS

VAPOR SAMPLING. The condensation method for the sampling of certain vapors has been widely used in industrial hygiene investigations. In this paper the characteristics of the condensation-type sampling device in its simplest and commonest form are discussed. The method described makes use of a U-tube immersed in a freezing mixture of dry ice and methyl alcohol (—78C). [*"The Efficiency of the Condensation Method for Sampling Certain Vapors," by F. H. Goldman and J. M. Dalla Valle. Published in the Public Health Reports, pages 1728 to 1733, September 22, 1939, issue. Copies available from the Superintendent of Documents, Washington, D. C. Price, 5 cents.*]

ESTIMATING FUMES IN AIR. The vapor-pressure instrument described consists of two identical 65 cc. brass cells partially filled with bronze balls and provided with inlet and outlet valves. The contaminated atmosphere is drawn through one cell and frozen out. All valves are then closed, the instrument is warmed in a water bath and then shaken. It is then connected to the manometer and the pressure read. The second cell serves as a compensator and corrects for pressure changes due to temperature and water vapor. Two correction factors, necessary for obtaining the true vapor-pressure reading, are given. Formulae for computing the concentration in parts per million are given and a nomogram for the determination of the vapor pressure of several solvents is included. [*"A New Vapor Pressure Instrument for Determining Organic Solvents in Air," by L. Silverman, G. M. Reece and P. Drinker. Published in the Journal of Industrial Hygiene and Toxicology, September, 1939, pages 270 to 278. Journal Published by the Williams & Wilkins Co., Mount Royal & Guilford Aves., Baltimore, Md. Price, single copies, 75 cents.*]

STEAMFITTING APPRENTICESHIP. National Standards outlining the methods and practices that have generally proved most successful in training steamfitting apprentices. They represent the fundamental requirements for journeymanship regardless of local conditions. They are presented as a guide for local associations of contractors and of journeymen interested in jointly establishing systems of apprenticeship or improving the standards governing apprenticeship systems already in operation. [*"National Standards for Steamfitting Apprenticeship." Bulletin No. 28. Published by the Federal Committee on Apprenticeship, Division of Labor Standards, United States Department of Labor. Paper cover; 8½ x 11 in.; 11 pages. Available on request.*]

NEWS OF THE MONTH

Thulman Describes FHA Interest in Low Cost House Heating; Deplores Lack of Usable Performance Data

BOSTON — Robert K. Thulman, mechanical engineer, technical division, Federal Housing Administration, was the guest speaker Jan. 16, at the monthly meeting of Massachusetts chapter, ASHVE. His subject was "Methods of Heating Low Cost Houses," which was preceded by a technicolor film entitled "Homes of Today." Mr. Thulman discussed the heating systems at the Colonial Village project, Clairton, Pa., the experimental heating systems in five houses at Greenbelt, Md., and the proposed method of testing heating equipment for houses at the National Bureau of Standards. Professor H. C. Moore, Massachusetts Institute of Technology, presided.

Mr. Thulman, in his position as mechanical engineer for the Federal Housing Administration is concerned with the acceptability of mechanical equipment for the houses on which the administration insures the mortgages. He said in part:

"The determination of the acceptability of heating equipment in houses insured by the FHA, is guided by two principles—the same two in fact that govern the acceptability of the whole house. These are contained in the preamble to the Housing Act which states that the purpose of the Act is to encourage improvement in housing standards and the second that the 'project with respect to which the mortgage is issued must be economically sound.'

"Acceptability of mechanical equipment according to these two principles might appear to be a comparatively simple matter. There are, however, some practical considerations which interfere with this facility. The mechanical equipment should be, and usually is, studied from the standpoint of function. The whole property rating procedure is based upon a weighting of the factors considered in relation to the marketability of the house.

"The acceptability of a particular piece of heating equipment or heating system must be considered not only from the standpoint of the family that builds and owns the house, but also the probable demands of other families who are likely to live in it, if the original owner gives it up and it is offered for sale. In consideration of the economic soundness of the heating equipment, durability, adequacy and operating economy are the items given most consideration.

"Unfortunately we lack accurate and readily usable data on these important items. We do not know how to judge the durability of one system as compared to another. Relative operating economies of two different heating units, if available at all, are obscured in laboratory test data to such an extent that it is discouraging, if not impossible, to dig out the necessary information. There are few yardsticks by which the performance of different heating devices may be judged. Often the successful performance of a boiler in one house may be due in no small measure to the way it is installed and connected, and not because of any inherent quality of design. These deficiencies in our knowledge often result in unfairness of the valuation placed upon the house.

"The manufacturer of a good oil burner cannot produce sufficient technical evidence that his burner is better and therefore entitled to a higher valuation than the poor product of another manufacturer. The result, disappointing to the quality manufacturer though it may be, is that the FHA valuator tends to place the same value on the good equipment that he placed on the poor. Often the value of the poor equipment is its actual cost or less.

"We have recently made an attempt to provide a yardstick for more intelligent comparison and rating of oil burners. This has culminated in a Commercial Standard which provides for field testing for determining CO_2 firing rate and stack temperature. We hope that the development of this standard, its use and intelligent enforcement and the educational effect of it will encourage the quality manufacturer to enter the low cost house market more actively. A similar attempt is being made to develop standards for warm air heating and for steam and hot water boilers.

"Professor Wilkes' tests here at M.I.T. on domestic hot water heaters have formed the basis of an effort we are making to encouragement of testing procedure for this kind of equipment which will show the performance of it under conditions approximating those of actual use.

"There have been many attempts by banks, insurance companies, newspapers and government departments to establish family budgets for various incomes. None of these, however, seems to have included specifically the amount which can reasonably be afforded for comfort. In order to provide at least a basis for discussion, I prepared some time ago a basic specification which established arbitrarily budget amounts for heating a low cost house. In doing this I felt it necessary to take into account variations in temperature as well as of income. So the country was divided up into zones which were a combination of the familiar degree day map and the design temperature map, superimposing the latter on the degree day map, thus establishing five basic zones.

"Zone 1 consists of all the area above the 8,000 degree day and minus 20 degree lines. Zone 2, the area between the 6,000 and 8,000 degree lines and the minus 10 and minus 20 temperature lines, and so on down to Zone 5 which consists of the area below the 2,000 degree day lines and below the plus 20 degree temperature lines. Budget amounts for heat in terms of income and locality were prepared. From a maximum of 4.6% for a $1,000 income in Zone 1 the percentage allowable for heating decreases by increments of .4% for each zone southward and, beginning with the 4.6%, increasing increments of .05% are added for each $250 additional income. Thus families in colder climates should allow more for heat than a family of the same income in warmer climates, and as income increases, more can be added for comfort such as heating.

"There are very few parts of the United States in which a heating system or heating device of some sort is not necessary. Every state in the Union has at one time or another recorded a zero temperature, and only seven states have never recorded a temperature 20 degrees below zero. There is therefore ample justification for inclusion in a low cost house of some means of artificial heat because of climatic conditions.

"In 1935 and 1936 the Federal Public Health Service in a house to house survey discovered that on an average winter day six million persons were confined to their homes because of sickness, 65% of them in families with annual incomes below $1500. While the survey did not consider how many of these homes were maintained at comfort conditions, I think we may assume that a large percentage were inadequately, improperly, or unevenly heated, many not at all. It should be justifiable, therefore, to include heating equipment from the health standpoint also.

"All too often the architectural answer to the problem of low cost housing has not been sufficiently balanced by considerations of economic soundness. Often these houses are of con-

(Continued on page 66)

Labor Dept. Revises Factory Codes

ALBANY—Revision of five existing industrial codes and the development and drafting of four new codes were completed, and the revision of three other codes was materially advanced by the New York State Labor Department during 1939, Industrial Commissioner Frieda S. Miller reports.

Industrial Code Bulletins upon which the department completed its work of revision and which are now ready for consideration by the State Board of Standards and Appeals for adoption, are as follows:

Bulletin 10, Rules Relating to the Equipment, Maintenance and Sanitation of Foundries and the Employment of Women in Core Rooms; Bulletin 14, Rules Relating to the Construction, Installation, Inspection and Maintenance of Steam Boilers; and Bulletin 23, Rules Relating to the Erection, Repair and Demolition of Buildings.

Four new codes which have been prepared by the Department and which will shortly go to the State Board of Standards and Appeals are: Rules on the Control of Silica Dust in Stone Crushing; Rules on the Control of Silica Dust in Stone Cutting and Finishing; Rules to Prevent Mist in Mines, Tunnels and Shafts, and Rules for the Control of Toxic Gases After Blasting in Mines, Tunnels and Shafts.

The two new Codes relating to control of silica dust and the revision of Industrial Code Bulletin 10, which will add Rules Relating to the Control of Fumes and Dusts in Foundries, are a development in the Department's campaign against silicosis.

Space Heater Makers Elect Atwill

CHICAGO—At several committee and divisional meetings held here during the Chicago Furniture Markets, the oil space heater manufacturers set a minimum efficiency requirement for the issuance of The Institute of Cooking and Heating Appliance Manufacturers rating seal.

The chief results of the meeting of the technical committee on January 9 in Chicago were: (1) the addition of the minimum efficiency requirement in connection with the issuance of the Institute's seal; (2) a revision of the standard code for rating oil burning space heaters on the basis of a year's experience under the tentative code adopted early in 1939; (3) the adoption of a new combustion chart, and (4) a report on the United Laboratories' work in perfecting a smoke meter for use in testing space heaters.

A. T. Atwill, president of the Quaker Manufacturing Company of Chicago, was unanimously re-elected as chairman of the oil division for 1940.

Vernon Addresses Chicago Chapter

CHICAGO—Eighty-eight members and guests of the Illinois chapter, ASHVE, attended the November meeting which was addressed by J. R. Vernon, whose subject was Automatic Temperature Control For Air Conditioning Systems. The speaker chose the catalog type of presentation for his remarks, illustrating his discourse by means of lantern slides which showed certain fundamental control principles and also actual devices as manufactured by various temperature control people. Basic instruments were described first, and their application was traced from the simpler uses in heating and ventilating down to the more complex requirements which they must satisfy in air conditioning. Hook-up diagrams were used to indicate the principles involved in the proper application of the apparatus for temperature and humidity control.

Bringing out the fact that the automatic temperature control industry is alive to the responsibilities entrusted to it by air conditioning engineers, manufacturers, contractors, and users, Mr. Vernon showed and described many of the special devices which have been developed during the last few years to meet these new needs. Their characteristics were brought out by means of performance charts and diagrams, and their fields of application were indicated by drawings of typical installations.

In closing, Mr. Vernon entered a plea for adequate control systems, for air conditioning installations, pointing out that the right type of control plant, carefully thought out and painstakingly installed may serve as an adequate mechanical brain for the installation, a servant always on duty, in the interests of satisfaction to the ultimate users. The danger of "Goldberg" controls was pointed out, however, with the contention that only just the right devices engineered and installed with due consideration of the requirements of the plant would solve the problems in an adequate manner.

Texas City Plans District Cooling

GALVESTON—Air conditioning is to be tried out here on a wholesale basis. The conditioned air will be distributed from a central station just like steam in most cities.

A 50-year franchise has been granted for the installation and operation of a cold water distribution system for air conditioning buildings in an area six blocks long and five wide in the business district. The service will be metered and the customers will pay only for the amount of air conditioning that is used.

Predicts 20% Factory Building Gain

CLEVELAND—The stage is set for a substantial rise in the volume of industrial construction during 1940, according to a year-end Statement by George A. Bryant, Jr., executive vice president of The Austin Company, Cleveland.

With leaders in almost every field responding to generally improved business by a careful re-examination of the efficiency in their own plants, he said, conditions today would indicate an increase of 20% or more in the total volume of factory building during the coming year.

Long delayed re-adjustments are being pressed. If the work required to eliminate bottlenecks, non-productive handling operations and other uneconomic factors in the operation and maintenance of many plants is carried forward, this alone would take care of the increase, he added.

The fact is that if available new machinery and today's advanced production methods were to be applied generally in modern plants, the cost of many manufactured articles could be cut materially, and in some cases enough to permit a one-third reduction in the selling price and still leave the manufacturer a good profit, Mr. Bryant stated.

Stacey Addresses ASME in New York

NEW YORK—A. E. Stacey, Jr., vice-president of Buensod-Stacey Air Conditioning Inc., was the speaker at a meeting here of the Air Conditioning Seminar of the metropolitan section, ASME. To the largest gathering of the year, Mr. Stacey, whose subject was Industrial Air Conditioning, outlined the growth of the air conditioning industry illustrating his talk with slides and drawing on his long personal experience in this field for illustrations.

Mertz Opens Trade School in K.C.

KANSAS CITY—A trade school offering courses in air conditioning, refrigeration, heating and mechanical drawing and known as the E. J. Mertz School of Air Conditioning and Refrigeration has been started here at 1806 Grand Avenue. A complete refrigeration and air conditioning course including practical as well as theoretical training has been made available.

The school is owned and operated by E. J. Mertz and E. G. Starrett. Mr. Mertz, who formerly supervised the erection of plants and equipment for W. T. Conroy Company of Kansas City, is educational director and chief instructor. Mr. Starrett is business manager.

Stove Developed for New England

NEW HAVEN, CONN.—Development of a new type of wood burning stove, capable of heating two or three rooms and requiring fills only once or twice a day, is regarded by New England foresters as bringing new hope to farm woodlots which long have suffered for lack of a suitable market for cordwood. Besides this, the farmers themselves will be able to heat their homes with a minimum of expense and effort.

The new stove, to which has been given the name of "Char-Wood," was developed by the Connecticut Forest & Park Association and Professor Lauren E. Seeley of Yale University, is now in production. It burns wood at an estimated 90% efficiency. Because of a radically new design, the heater operates on the principle of "destructive distillation," burning both gas distilled from the wood in the process of combustion, and charcoal formed in its operation. Importance of the stove in forestry is said to lie in the fact that its efficiency and convenience make a return to wood fuel likely on the part of rural dwellers.

N.J. Utility Adds 2380 Gas Heat Jobs

NEWARK, N. J.—A new high mark in the number of gas heating installations, an increase in both industrial and domestic gas sales, and a gain in both commercial and domestic consumption of electricity during 1939 was announced here by Public Service Electric & Gas Co. on the basis of records for the 11 months ended Nov. 30 and estimates for December.

During 1939 there were 2,380 gas heating installations made in buildings in the area served by the company, according to announcement. This was the largest number of installations in any year and 30% higher than the corresponding 1938 figure. There are approximately 10,000 buildings heated with gas from the company's mains. Sales of gas in 1939 for heating homes and buildings were the largest in the history of Public Service and showed a 28.3% gain over 1938.

Voss Speaks at ASRE Meeting

CAMBRIDGE, MASS.—"Compressors and Compressor Valves" were the subject of a lecture given before the Boston section, ASRE, Jan. 26, at the Massachusetts Institute of Technology. Mr. Voss, who has been engaged in the manufacture of refrigerating equipment for many years and is responsible for many developments and improvements in refrigerating apparatus, pointed out important mechanical features that have been overlooked, while the basic structures of refrigerating apparatus have been improved.

Medical Aspects of A.C. Discussed

CHICAGO—Dr. R. W. Keeton, head of the Department of Medicine, University of Illinois, was the first speaker on the program of the December meeting of the Illinois chapter, ASHVE. Dr. Keeton opened his remarks by giving an outline of the background of the research work being conducted by the University in conjunction with the society's committee on research. This resumé included facts on the use of air conditioning in hospitals, the work done to date, investigative problems in the hospital air conditioning field, and proposed extension of equipment for use in investigating these problems.

Dr. Keeton introduced Prof. A. E. Hershey, Department of Mechanical Engineering at the University, who discussed the importance of the mean radiant temperature of the surroundings as one of the factors necessary in describing a physical environment. He described the principle and method of calibration of three instruments for measuring this temperature, namely, the eupatheoscope, the thermal-indicator, and the globe thermometer.

Prof. M. K. Fahnestock, also of the Department of Mechanical Engineering, followed Prof. Hershey with a discussion of the use of the instruments described by him. Tests were made first in a typical non-uniform room, simulating a corner room in an average residence and, second, in a fairly uniform environment afforded by a test room designed for conducting studies on the physiological effects of atmospheric environment. Three different methods of heating the rooms were used and the data resulting from the tests included a comparison of the equivalent and mean radiant temperatures with the dry bulb temperatures under these methods. The data presented from tests in the uniform environment room showed the good agreement between the dry bulb, equivalent and mean radiant temperatures over a wide range of dry bulb temperatures. This agreement is an index of the uniformity of the environment and shows that the air and the inside surfaces of the room were approximately at the same temperature.

Dr. Ford K. Hick, of the Department of Medicine of the University, was the next speaker. Dr. Hick correlated the engineering facts covered by the two previous speakers with their significance from the medical standpoint. He presented data on tests with healthy young adults as subjects which tend to indicate circulatory abnormalities were a response to excessive heat and that such abnormalities constitute heat exhaustion. The speaker also touched briefly on studies which are being conducted at present, but are yet not carried to their conclusion.

Los Angeles Group Wants Ordinance

LOS ANGELES—The annual election meeting of the Heating, Piping and Air Conditioning Contractors' Association of Southern California was held at Hotel Rosslyn January 9. In line with the organization's policy, the board of directors was elected first and thereupon chose the new officers for 1940.

Board members are: Joseph Herman, of the Herman Air Conditioning Co.; Loy Johnson, Johnson Washer Co.; H. G. Cary, of the H. G. Cary Co.; Arthur Felthaus, S. C. Brown Co.; and F. D. Reed, of the F. D. Reed Co., all of Los Angeles.

Officers chosen by the board are: president (re-elected), John M. Moriarity, head of the Consolidated Heating and Ventilating Co., Los Angeles; vice-president, Charles Ballway, American Engineers and Contractors, Ltd., Los Angeles; treasurer, B. K. Stoneman, Stoneman Heater Co., Los Angeles; secretary (re-elected), Frank J. White, of Holloway and White Heating Co., Pasadena.

One of the principal activities of the Southern California association during the coming year, Mr. Moriarity announced, will be a concerted drive for action on a steam heating ordinance. More than a year ago the association sponsored the drafting of an ordinance providing for municipal regulation of steam heating installations, including inspection of piping, boilers and general fittings, the appointment of an examining board for contractors and journeymen, and general provisions that would give the heating and air conditioning industry as effective regulation and supervision as is accorded the plumbing industry. Opposition was strong enough to keep the proposed ordinance from coming to a vote in the city council chamber, and it has been pigeon-holed in the council committee for more than a year.

Imperative need exists for a Los Angeles Ventilating Code, in the opinion of A. B. Wicks, director of the heating and ventilating division of the Municipal Department of Building and Safety. Currently contractors are not obliged to obtain a permit for installing a ventilating job, other than the general permit from the Building and Safety Department for such phases of ventilating work covered by the Municipal Code.

Stoker Sales Heavy in St. Louis

CHICAGO—The St. Louis Smoke Department reports that installation permits for automatic firing units in 1939 were issued for 2,526 stokers, 732 gas burners and 377 oil burners, according to the Committee of Ten.

Stoker Dealers Elect L. G. Briggs

CHICAGO — L. G. Briggs, manager, Chicago retail branch of Fairbanks-Morse, was re-elected president of the Midwest Stoker Association at the tenth annual meeting of the association held here January 19. E. M. May, manager of Combustioneer's Chicago retail branch, was re-elected vice-president and E. W. Jones, office manager, Chicago branch, Iron Fireman Mfg. Company, was elected secretary-treasurer. These three officers together with Mount Burns, manager, Chicago retail division, Link-Belt Company, and E. H. Markland, Chicago division manager, Whiting Corporation, make up the new executive committee of the association.

In reporting to the membership on last year's activities, President Briggs stated that the retail stoker industry, through the Midwest Stoker Association, had improved its position in the Chicago market considerably as evidenced by the sale and installation of over 5,000 units in 1939.

The association voted to create two new special divisions: service and installation men, and credit managers and accountants. Monthly meetings of these groups will be held in 1940.

Thulman Talks on FHA Heating

(Continued from page 63)

crete, which has a high coefficient of heat transmission, and the occupant of the modern house finds himself comfortable only at the expense of high fuel costs. While the proper approach to an essentially economic problem should have been strictly along economic lines, with only minor consideration to the points which architecture considers so important, it also seems that a solution, or a number of solutions to the heating problem may be possible if equipment can be developed without restriction to accepted and usual design procedure.

"If the maximum heat loss of a house should be restricted to definite amounts related to income, it is logical to use a domestic hot water heater as the basic heating unit and domestic hot water as the heating medium."

The speaker introduced many slides, showing various types of heating equipment and houses in the Greenbelt and Clairton projects, with comments showing how they had worked out, and how they were installed. Continuing he told of an experimental house built by the National Bureau of Standards in which various types of heating systems can be installed, studied and later replaced by others, from the results of which the FHA and the Bureau hope to establish a "yardstick" by which performance and economy of heating devices may be measured.

Furnace Builders Attack City Code

PORTLAND, ORE.—Attacked from the standpoint of constitutionality as well as obsolescence is the ordinance of this city, which is known as the heating and ventilating code of the city. An injunction suit was filed by a group of plaintiffs to have a reform inaugurated and provisions of this important ordinance changed to mark new progress in the fields. The injunction suit was under way in January before Circuit Judge L. P. Hewitt in Portland, without a jury.

Specifically, the heating and ventilating code prohibits the sale of steel warm air furnaces using oil as fuel unless they have combustion chambers of at least No. 8. U.S. Standard gauge. Plaintiffs are manufacturers of oil furnaces and a group of Portland retailers who find activities curtailed by the ordinance.

Officials are being asked in this legal action to be enjoined from prohibiting the sale and installation of oil furnaces having combustion chambers less than No. 8 gauge.

Factory Building Up, N.Y. Reports

ALBANY—For the fifth successive month the number of industrial building plans submitted for approval to the New York State Department of Labor exceeded all previous corresponding months of the 16 years in which plans have been so submitted when, in December, 137 such plans were filed.

The December plans represent contemplated investments of $2,077,050.

Urdahl Speaks to Pittsburgh Group

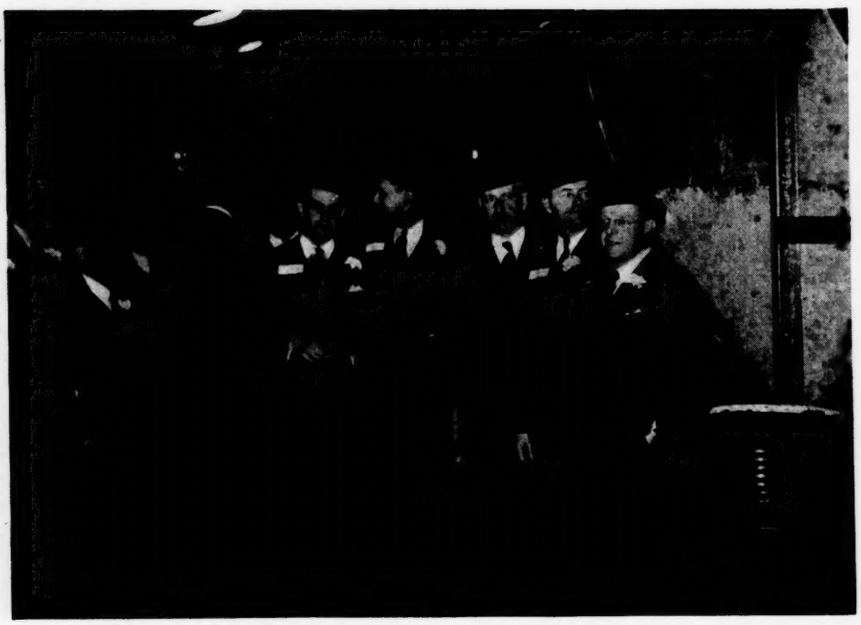
PITTSBURGH—T. H. Urdahl, consulting engineer, Washington, was the speaker at the December meeting of the Pittsburgh chapter of the ASHVE. His talk entitled, "The Referee" dealt with the relationship between the buyer, seller and engineer in the heating and air conditioning field.

The talk received considerable attention particularly the stories taken from his experiences where he was called in to act as referee between the contractor and buyer of air conditioning equipment, when difficulties arose.

As a suggestion that would avoid many contract controversies Mr. Urdahl emphasized the advantages of making all guarantees as to performances of a system all inclusive. This would not only be of an advantage to the contractor but buyer as well. Guarantees of this kind would avoid the temptation of some buyers from seeking loop holes with which to withhold payments unjustly. Exceptions in the contract, extras and other embarrassments would be less likely to arise.

Young Radiator Holds Open House

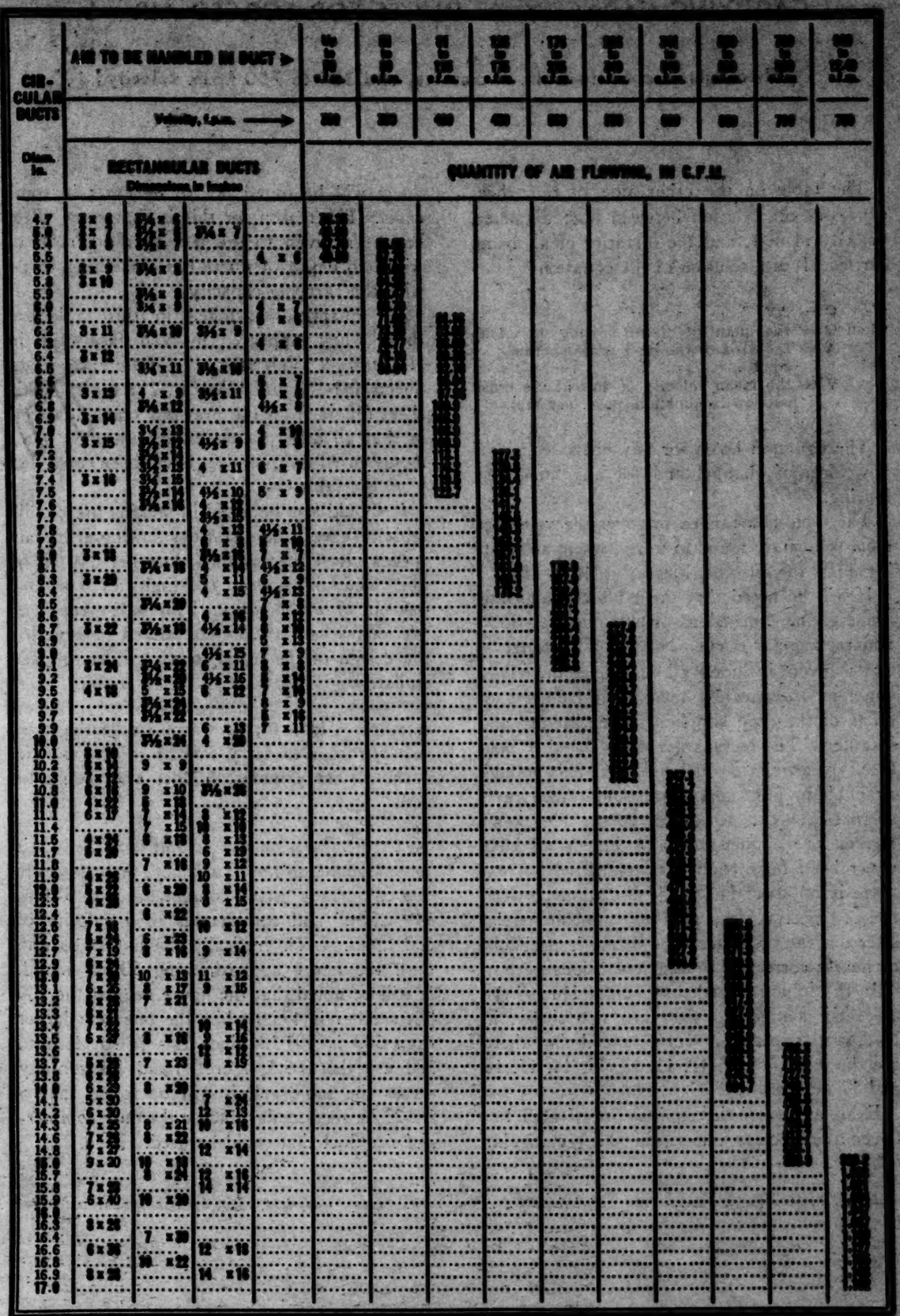
RACINE—Over 1500 people attended the open house and reception held Dec. 17 at the factory and offices of Young Radiator Co. The open house was the idea of President Fred Young in an effort to acquaint workers with all of the work in the plant and to reveal the importance of every role assumed by every employe.



Some of the one hundred Buffalo Forge sales engineers inspecting the company's factory during the annual sales meeting. After two days at the Cleveland heating and ventilating exposition, branch engineering representatives of Buffalo Forge Company and Buffalo Pumps, Inc., spent two days at the factory for a discussion of the latest engineering developments and display of new products.

CARRYING CAPACITY OF DUCTS FOR FORCED AIR—6

(When ducts are 4.7 to 17 in. in diameter and 300 to 750 f.p.m. velocity.)



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H. & V.'s REFERENCE DATA—167

CARRYING CAPACITY OF DUCTS FOR FORCED AIR—6

(When ducts are 4.7 to 17 in. in diameter and 300 to 750 f.p.m. velocity.)

The table on the other side of this sheet expresses the relation between duct diameter, velocity of flow, and the quantity of air being carried. It is a solution of the equation

$$Q = AV$$

when Q = the quantity of air flowing, in c.f.m.,
A = the area of the duct cross section, sq. ft.,
V = the mean velocity of flow at the cross section in question, in ft. per min.

The equation holds for any cross section of any form of channel and for any substance flowing.

The table is arranged to cover the velocities most frequently found in forced warm air heating ducts for air quantities up to 1250 c.f.m.

It will be noted that the table contains columns giving dimensions of both circular ducts and rectangular ducts. The list of rectangular ducts given includes all those commercially listed as *standard* by most manufacturers of ducts of the type supplied to contractors and installers. The rectangular ducts listed in bold face type are those which are commonly enough available by most makers of standardized ducts so that they can be considered as being *commercial sizes*. Duct sizes and dimensions have never been fully enough standardized so that there is no strict line of demarcation between the commercial sizes and the non-commercial sizes but the bold face type listing is probably as nearly correct as present conditions permit.

In the columns headed "Circular Ducts" the so-called commercial sizes are also shown in bold face type and it will be noted that these are the 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 in. sizes.

Examination of the equivalence of area between the circular ducts and the rectangular ducts will be found not to be exact in some cases. The reason for this is that some effect has been given to the fact that the ratio of width to depth of ducts has something to do with the carrying capacity.

Air quantities included in this table are those which appeared in bold face type in HEATING & VENTILATING's Reference Data Sheets 161-162 and 163-164. The table on this sheet differs from the previous ones, however, in that all other values except the ones commonly used in practice have been excluded from the table.

It should also be noted in making use of this table that with the quantities flowing at the air speeds given the frictional loss per 100 ft. of duct will fall between the limits of 0.06 and 0.08 in. of water gauge. This is the range of frictional losses usually considered suitable for the design of the usual forced air heating installation.

Example.—In a forced warm air heating system a duct is to carry 500 c.f.m. to a certain room. What commercial duct sizes could be used?

SOLUTION: Look in the columns marked "Air to be Handled in Duct" and note that the figure 500 c.f.m. falls in the column headed "341 to 549 c.f.m." and corresponds to a velocity of 600 f.p.m. Look vertically down this column until the figure approximating 500 is found. It will be noted that the figure nearest the 500 but smaller is 495.0 while the one next larger than 500 is 503.3. Since this is so close to 500 use the 503.3 figure. Read horizontally across the table and it will be found that a 6 x 22 in. rectangular duct is the only *commercial* size duct that could be used.

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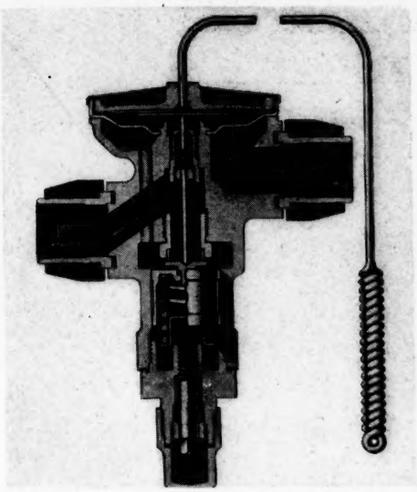
NEW EQUIPMENT



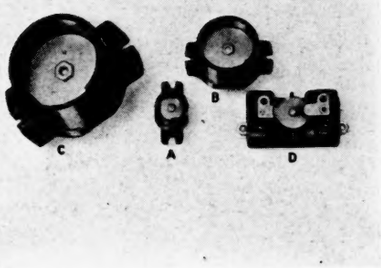
Capacity 12- to 20-ton with Freon.

Detroit Expansion Valves

NAME—Detroit Dura-Fram Automatic and Thermostatic Expansion Valves.
PURPOSE — For controlling the flow of refrigerant.
FEATURES—These valves are of single diaphragm construction with all joints silver-soldered and the diaphragm made of stainless steel. Needles and seats are made of a corrosion resisting alloy. Power elements on the thermostatic type valves are gas charged which is said to limit the suction pressure when starting up the system and to prevent overload to the motor and compressor.
SIZES AND CAPACITIES — Thermostatic expansion valve, No. 892, capacity of a half-ton on Freon or sulphur dioxide, 9/10 of a ton on methyl chloride at 60 lb. pressure drop. No. 895, one ton on Freon or sulphur dioxide, 1.8 ton on methyl chloride at 60 lb. pressure drop. Thermostatic expansion valve, No. 893, adjustable type, half-ton on Freon; No. 897, adjustable type, one ton on Freon. No. 894, non-adjustable, half-ton on Freon. No. 896, adjustable, one ton on Freon. Nos. 786, 787 and 788 are for air conditioning applications and are rated from 3 to 20 tons on Freon.
MADE BY — *Detroit Lubricator Company, 5900 Trumbull Ave., Detroit, Mich.*

Spencer Motor Protectors

NAME—KLIXON protectors.
PURPOSE—For protecting a.c. motors from overheat and overload.
FEATURES—When built into a motor, manufacturer states that these protectors automatically cut the motor out of the line the instant damaging temperatures are reached in the motor. They are applicable for use with single and polyphase motors. Protectors available and application ranges are as follows: (a) ½ in. protector provides inherent overload and inherent overheat protection for fractional hp. single phase motors up to ¼ hp. Also used as an inherent temperature control unit on large integral horsepower poly-phase motors; (b) 1 in. protector provides built in overload and overheat protection for fractional horsepower, single phase motors through 1½ hp. (c) 1½ in. protector provides inherent overheat and overload protection for single and polyphase motors up to and including 3 hp. On single and poly-phase above 3 hp. available for inherent protection against heating and excessive current (breaking pilot circuit of motor contactor, not the load directly). (d) Two

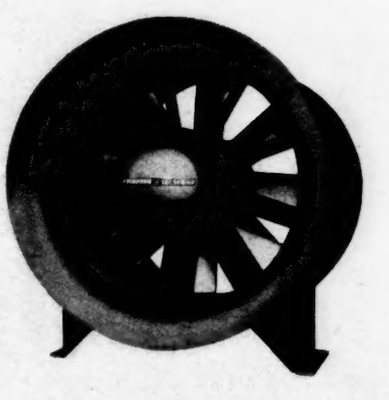


For preventing motor overheat and overload.

pole protector, for certain types of fractional hp. repulsion-start induction and capacitor motors.
MADE BY—*Spencer Thermostat Company, 34 Forest St., Attleboro, Mass.*

Buffalo Forge Fan

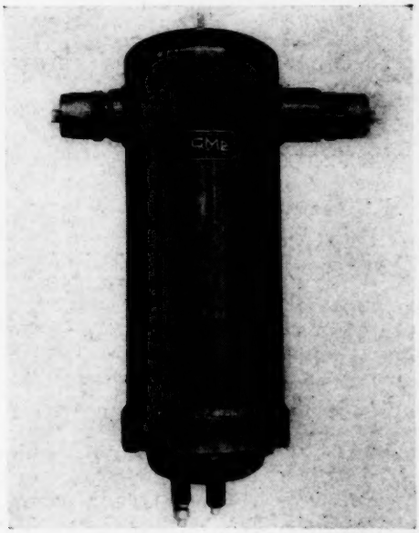
NAME—Buf-flow limit-load axial flow fans.
PURPOSE—For moving air.
FEATURES—This fan is said to be the result of thorough research and tests undertaken to improve efficiencies by correct proportioning of blades, hub, and inlet and outlet, to reduce objectionable noise by lower speeds and the proper directional vanes which reduce turbulence; to improve pressure characteristics by producing non-overloading power characteristics. It is said that this fan has an especially high capacity factor which means that a smaller size than heretofore required will adequately handle the work. Available in Arr. 2 for V-belt drive or in Arr. 4 for direct drive and for either vertical, down, or horizontal discharge. For a blowing fan, a bell inlet is furnished. Exhausting unit furnished complete with an inlet cone, flanged for connection to existing duct work. Can be mounted on floor, ceiling or side wall.
SIZES AND CAPACITIES—Seven sizes, ranging from 20 to 48 in. with capacities from 4800 to 69,360 c.f.m.
MADE BY — *Buffalo Forge Company, Buffalo, New York.*



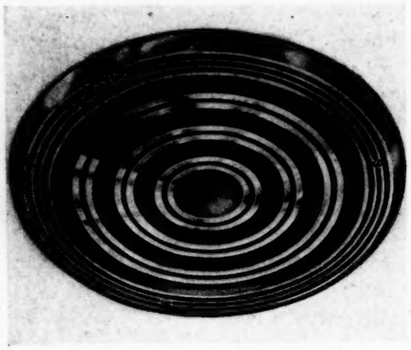
Designed to give higher efficiency.

Acme Oil Separator

NAME—Acme oil separator.
PURPOSE — For separating oil from the refrigerant.
FEATURES—Separator is designed to be placed in the discharge line between the compressor and the condenser. The oil laden entering gas is distributed by a spiral guide inside a perforated tube and forced through a filtering material which is said to cause a complete break up of the gas and oil and results in the oil falling into the bottom of the separator. An accumulation of oil raises a float valve permitting the return of the oil to the compressor crankcase. The shell of the oil separator is made of pressed seamless steel with float valve assembly and bottom welded to the shell or flanged according to the model.
SIZES AND CAPACITIES—Five sizes with capacities ranging up to 50 hp.
MADE BY — *Acme Industries, Inc., Jackson, Mich.*



For returning oil in refrigerant systems.



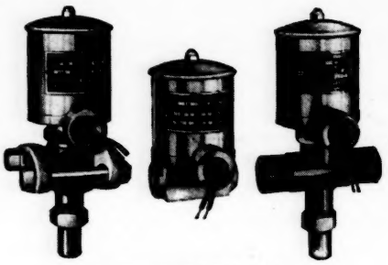
Tuttle & Bailey Aerofuse outlet.

Tuttle & Bailey Aerofuse Outlet

NAME—Tuttle & Bailey Aerofuse Outlet.
PURPOSE — For introducing conditioned air into rooms.
FEATURES—The device consists of a series of cast aluminum rings shaped and spaced so as to form circular air passages with alternate low pressure areas. The manufacturer states that due to the special shape of the openings the supply air is delivered in a series of concentric jets. Each circular jet is said to turn outwardly immediately upon leaving the confinement of its passage to fill the nearest adjacent low pressure area. This action is said to result in a horizontal path of supply air which approximately parallels the ceiling. Manufacturer claims that due to this method of diffusion the supply air is brought in contact with the room air over the largest possible area immediately after leaving the outlet. It is further stated that the high rate of air mixture dissipates the energy of the supply air stream well before it reaches the occupied zone and the rapid mixture of supply with room air causes prompt temperature equalization.
SIZES AND CAPACITIES—4½ to 36 in. diameter, with capacities ranging from 25 to 4500 c.f.m.
MADE BY—*Tuttle & Bailey, Inc., New Britain, Conn.*

Spoehrer-Lange Solenoid Valves

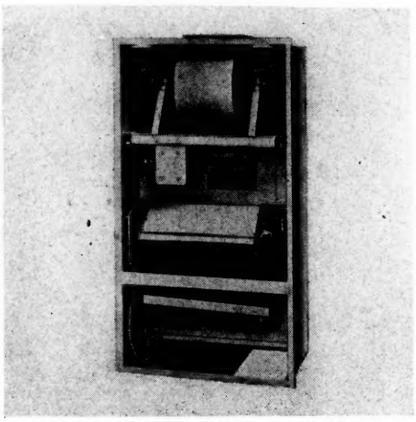
NAME—Sporlan solenoid valves.
PURPOSE — For controlling the flow of liquids.
FEATURES—There are four types of these valves available. Type 10 valve and type 40 are for Freon and methyl chloride liquid lines; type 20 is for small water lines, and type 30 is for liquid ammonia lines. Manufacturer states that these solenoid valves can be completely taken apart in the field for cleaning or servicing and can be reassembled easily. It is claimed that the possibility of refrigerant leaks has been minimized by welding rather than by soldering the enclosing tube. The coils are stated to be moisture proof. Type 10 and type 20 valves have ⅜ in. F.P.T. connections while type 40 has sweat connections for either ⅞ in. or 1⅛ in. OD copper tubing. The type 30 valve is a flanged valve which can be used separately or with the Sporlan types CA or NA thermostatic expansion valve.
CAPACITIES — Type 10, 4 ton of Freon; type 20, 1 gal. per min. water; type 30, 15 ton liquid ammonia, and type 40, 10 ton Freon.
MADE BY—*The Spoehrer-Lange Company, 3723 Commonwealth Ave., St. Louis, Mo.*



Easily disassembled for cleaning.

Webster-Nesbitt Conditioners

NAME AND MODEL NO.—Residential Air Conditioner, Series D, R and A.
PURPOSE — To meet the heating and air conditioning demands of present-day housing.
FEATURES — Series D is a compact, concealed unit for heating small apartments and multiple dwellings. It is available in three models with capacities from 300 to 600 c.f.m. standard air. Series R is for residence air conditioning — heating and air cleaning, or for winter heating and humidifying, air cleaning and summer cooling —with steam or forced hot water and chilled or well water. It is offered in eight models with capacities from 750 to 4000 c.f.m. Series A is for air conditioning of apartments and multiple residences and offers a compact, concealed installation. It is available in four models, with capacities from 350 to 1000 c.f.m. standard air.
MADE BY — *John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa., distributed by Warren Webster & Company Camden, N. J.*

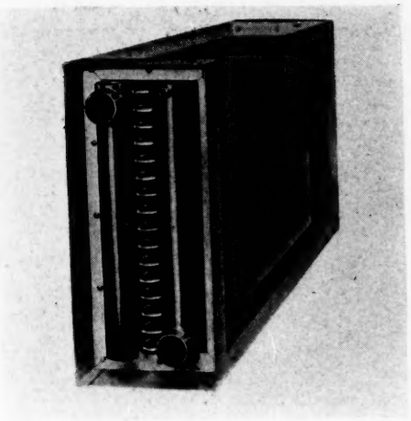


Webster-Nesbitt air conditioner series A.

Young Streamaire convectors.

Young Streamaire Convectors

NAME—Young Streamaire convectors.
PURPOSE—For heating air.
FEATURES — These convectors are made with two component parts, the heating element and the enclosure. The heating element consists of copper tubes through which steam or hot water passes, copper fins which act as extended heating surfaces and the supply and return tanks to which the piping connections are made and which are designed to distribute the steam or hot water properly through the tubes. The convectors are furnished with two types of heating elements. Type V, an elliptical tube element for use with vapor, vacuum, one pipe steam and hot water installations and type H, a round tube element for forced hot water heating systems. The type V elliptical tube has a large cross sectional area which is said to result in exceptional performance of this heating element on vapor or vacuum steam systems. These elements will stand operating gauge pressures of 50 lbs. per sq. in. saturated steam. The type H element copper tubes are equipped with specially designed spiral agitators to increase the rate of heat transfer. These convectors are designed for working pressures up to 100 lbs. per sq. in. hydrostatic pressure. The enclosures are made in 3 different types. They can be installed as free standing cabinets, wall hung cabinets, or can be partially recessed in the wall. They can also be completely recessed so that the front panels will be flush with the plaster, or, if desired, they can be furnished with plaster fronts so that only the upper and lower grilles are visible.
TYPES—Free standing cabinet convectors type C; wall hung cabinet convectors, type W; wall hung type convectors, type WS; partially recessed convectors, type S; fully recessed convectors, type R; bathroom cabinet convectors, type L and plastered-in concealed convectors, type P.
MADE BY—*Young Radiator Company, Racine, Wis.*



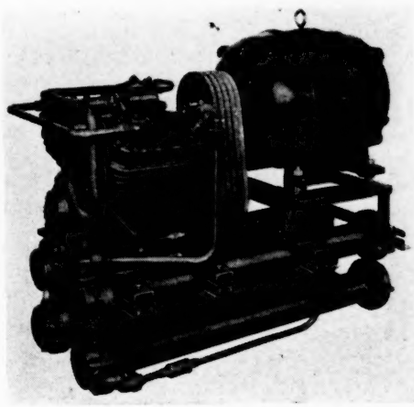
For cooling and dehumidifying or heating.

Nesbitt Cooling Surface

NAME—Nesbitt Series W Water Surface.
PURPOSE—For air cooling and cooling and dehumidifying with cold water or for air heating with hot water.
FEATURES—This is a fin and tube type surface which makes use of copper tubes and plate-type aluminum fins. Headers are of extruded copper tubing, with copper return bends and with all joints silver brazed. The counterflow principle of water circuiting is employed in all sections, and three water circuiting arrangements are provided. Sections are encased, free-floating, in galvanized casings, and are available in dimensions ranging from one to eight rows of tubes deep, in fin widths from 8.4 in. to 36 in. 16 finned lengths of 12 to 120 in. and three varieties of fin spacings.
MADE BY — *John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa.*

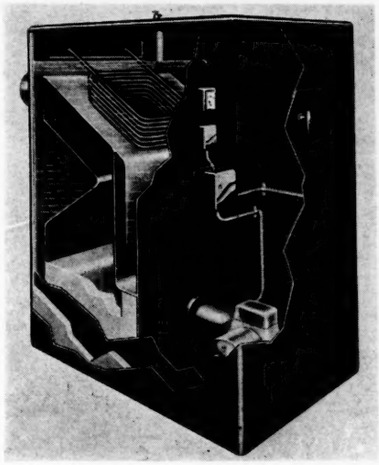
Servel Condensing Unit

NAME—Store cooler condensing units.
PURPOSE — For use with self-contained store cooler air conditioning units.
FEATURES—These condensing units are designed especially for use in the self-contained store cooler units. Units depart from the conventional in the arrangement of the elements on the base, in that the shafts of both motor and compressor are placed parallel to the long base dimension curve. This arrangement makes possible a much narrower unit than would be otherwise possible. A unique multiple-type shell-and-tube condenser is employed which permits the mounting of the condenser-receiver assembly directly below the motor and compressor and serves as a support for the structural members to which these elements are attached. All models are arranged for balanced cushion mountings.
SIZES AND CAPACITIES—Five sizes with capacities of 2, 3, 5, 7½ and 10 tons.
MADE BY — *Servel, Inc., Evansville, Indiana.*



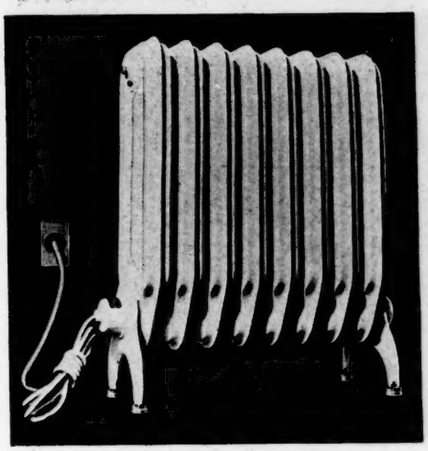
Servel 10-ton condensing unit.

Penn Domestic Water Heater



Supplies domestic hot water.

NAME — PennGun tankless water heater.
PURPOSE—For supplying domestic hot water using oil as a fuel.
FEATURES—A copper coil which is submerged in the hot water near the top of the boiler is used to heat the domestic water. The water in the boiler heating unit is merely a medium of heat storage and heat transfer. Boiler is constructed of steel and has wet water legs to the bottom. A standard gun type burner is built into the combustion chamber. Boiler is insulated with 1-in. asbestos insulation.
SIZES—2 sizes with tankless coils, one for supplying 200, and the other for supplying 300 gal. per hr. Four sizes with coils supplying storage tanks of 60, 120, 200 and 300 gal. capacity, also 2 units, one with coil for 60 gal. tank and a coil for 150 sq. ft. of hot water radiator surface and another with a 200 gal. per hr. tankless coil and a coil for 150 sq. ft. hot water radiator surface.
MADE BY—*Penn Boiler & Burner Mfg. Corp., Lancaster, Pa.*



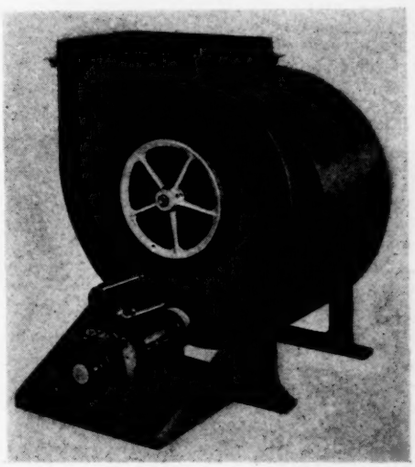
Portable electric radiator.

Electric Steam Radiator

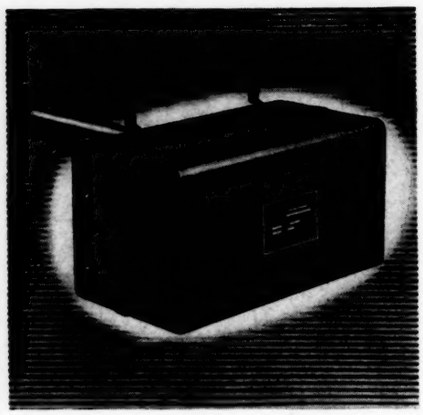
NAME—Portable steam radiator.
PURPOSE — For room heating using electricity as a heat source.
FEATURES—The manufacturer states that the radiator is similar in appearance to the conventional type radiator but it differs in that a small boiler is built into the unit itself. The boiler holds 2 quarts of water and generates steam when it is plugged into an electric outlet. Manufacturer states that the unit is light in weight and can be carried wherever additional heat is needed.
MADE BY — *Electric Steam Radiator Company, 6188—12th St., Detroit, Mich.*

Autovent Blower

NAME—Autovent belt drive blower.
PURPOSE — A complete blower unit for removing air.
FEATURES—The blower is set up as a complete unit with motor and V-belt drive and does not require special floor mounting or aligning of drives. It uses standard speed motors and is said to make an extremely flexible unit insofar as variation of air delivery is concerned.
MADE BY — *Autovent Fan & Blower Co., 1805 No. Kostner Ave., Chicago.*



Complete motor blower unit.



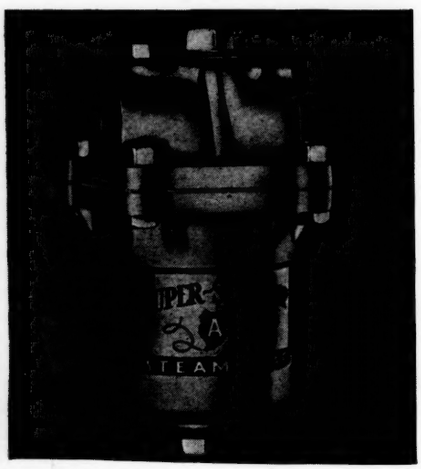
Outside temperature controls heating system.

Barber-Colman Heating Controls

NAME—Econostat.
PURPOSE—For regulating heating systems directly from outdoor temperatures.
FEATURES—Manufacturer states that the Econostat controls the heat supply in cycles by regulating the length of the "heat on" periods and varying them as the outdoor temperature changes. The "heat-on" periods are 100% at minimum outdoor temperatures, and are decreased proportionately to zero when the outdoor temperature rises to 70F. It is said that the Econostat is a complete control unit and requires no auxiliaries. It requires only mounting in a convenient proper location within the building with the sensitive element extending outdoors. It may be located on any floor or in the basement through a window panel. Unit can be arranged to operate zone valves or to operate the fuel firing device.
MADE BY—*Barber-Colman Company, Rockford, Ill.*

Anderson Steam Traps

NAME — Super-Silvertop traps No. 19 and 20.
PURPOSE—For draining condensate from steam equipment.

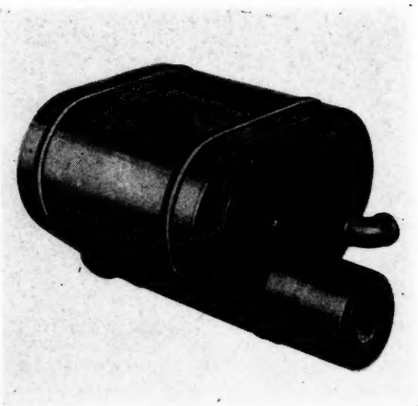


Greater capacity and higher pressure.

FEATURES — These traps supersede No. 11 and 12. Head and body of these traps are connected together with four bolts in a flange type connection. These traps have a bronze hexagonal bucket guide tube and the valve and lever mechanism is of new design with no pins or pivots. They have a drain plug at the bottom and the maximum operating pressure is 200 lb. as compared with 150 lb. on the old No. 11 and 12 traps. They are said to have a greater capacity than the traps they replace.
MADE BY—*V. D. Anderson Company 1935 W. 96 St., Cleveland, Ohio.*

National Machine Gas Burner

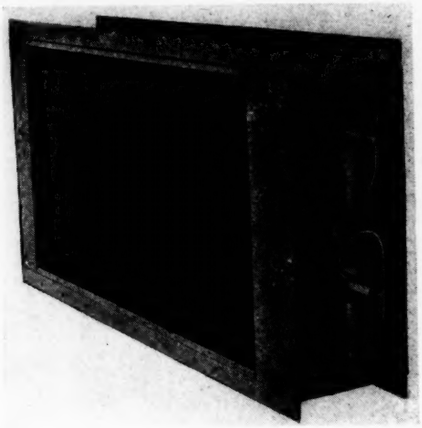
NAME—Lo-Blast gas power burner.
PURPOSE—A gas power burner with electric ignition for use with heating boilers and furnaces.
FEATURES—Burner has an electric ignition which eliminates the need for a pilot light, thus reducing the gas consumption. Manufacturer states that this burner is completely automatic and control is entirely by means of a room thermostat. Burner is equipped with a blower to deliver air under pressure to the mixing tube.
SIZES AND CAPACITIES—Two sizes. Unit No. 101 can be adjusted for gas inputs of from 100,000 to 240,000 B.t.u. Unit No. 102 handles gas input from 240,000 to 480,000 B.t.u.
MADE BY—*National Machine Works, 122 S. Michigan Ave., Chicago, Ill.*



Gas conversion burner with electric ignition.

Young Evaporators

NAME—Young evaporator coils.
PURPOSE—For cooling air by direct expansion of refrigerant.
FEATURES—It is said that this line of evaporator coils is designed especially for cooling use and that the tube size, tube spacing and fin surface have been all selected from the cooling standpoint. One of the main features of this coil is a special refrigerant distributor which is designed to distribute the mixture of liquid and gaseous refrigerant evenly. In doing this

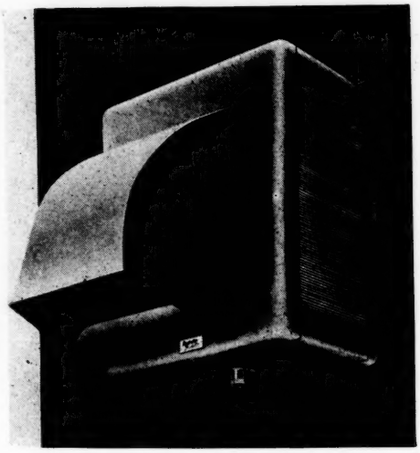


Perfect refrigerant distribution at all loads.

the two fluids are separated, distributed separately and finally mixed. Manufacturer states that this procedure results in a substantially equal superheat in all passes of the coil even under a wide range of loads. It is also claimed that since these coils are designed specially for cooling, the moisture given up by the air runs down the fins to the drain pan and makes moisture eliminators unnecessary except at very high velocities.
MADE BY—*Young Radiator Company, Racine, Wis.*

Webster-Nesbitt Projection Type Heater

NAME — Webster - Nesbitt Projection Type Heater.
PURPOSE—For air heating.
FEATURES—This heater is designed for ceiling suspension and gives results typical of blower-fan units. The unit makes use of a propeller fan and draw-through. It has a four-side element and high outlet velocities permitting heating of large areas. A specially shaped discharge nozzle directs the heat where needed.
MADE BY — *John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa., distributed by Warren Webster & Company, Camden, N. J.*



Webster-Nesbitt projection type unit heater.

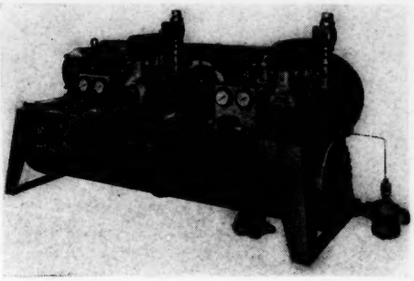
For heating large areas.

Buffalo Unit Heater

NAME — Buffalo Model "VD" Unit Heater.
PURPOSE—For heating large areas.
FEATURES—This unit heater is primarily suited for large area heating where machinery, cranes, and other obstructions make it more convenient to mount the units overhead—blowing down 15 to 50 ft. It is said to serve the double purpose of heating in winter and ventilating or circulating air for summer cooling. The outlet design provides four-way distribution with various velocities of discharge. The standard outlet can be adjusted or changed on the job which is said to make it possible to avoid cold spots or drafts. Other outlet designs are available to meet unusual conditions.
SIZES AND CAPACITIES—Three sizes, 24, 30 and 36 in. for 5000, 7500 and 10,000 c.f.m. respectively.
MADE BY — *Buffalo Forge Company, Buffalo, New York.*

Baker Condensing Unit

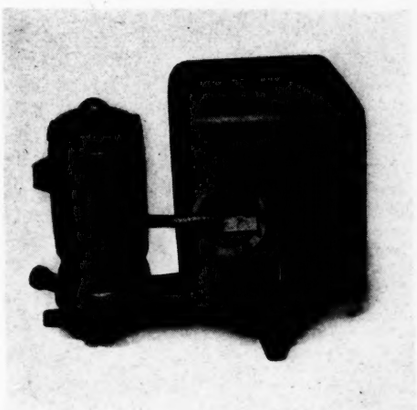
NAME—Baker Dual Freon condensing unit.
PURPOSE—For refrigeration.
FEATURES—Condensing unit consists of two 4-cylinder, vertical, reciprocating, single acting type compressors with gauge board mounted, multiple V-belt type drive with rigid belt guard and shell and tube type condenser-receiver—mounted on a rigid welded steel base. Cylinder blocks are of semi-steel while the cylinders, crankcase, and manifold are cast integral. Lubrication is provided by a built-in, high pressure gear-type oil pump. Roller bearings are provided on both drive end and blind end of the main bearing. Large capacity combination strainer and scale trap is provided for each compressor. Condenser-receiver has removable heads to facilitate cleaning. Motor controls are enclosed and fully automatic. An automatic water regulating valve of the adjustable type is provided, except when the unit is used with a cooling tower. Compressors are charged with Baker special Freon oil ready for operation.
CAPACITY—30 horsepower.
MADE BY—*Baker Ice Machine Company, Inc., 1529 Evans St., Omaha, Nebraska.*



30 hp. dual Freon condensing unit.

Weinman Condensate Return Pump

NAME — Unipump Condensate Return Unit.
PURPOSE—For returning condensate from heating systems to boiler.

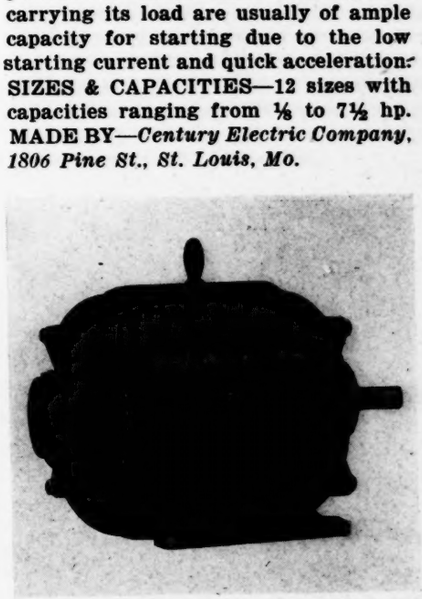


Suitable for 1500 to 30,000 sq. ft. radiation.

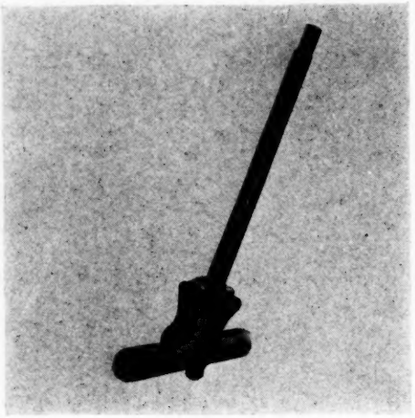
FEATURES—These condensate return pumps consist of a Weinman Unipump vertically mounted, a strainer, drip pocket, receiver and automatic float switch control. The pumps, which are fully bronze fitted, have a motor mounted vertically above them which is said to reduce the danger of submergence in the event of flood or other emergency conditions. This vertical mounting is also said to provide the lowest possible level for the pump — fully submerging the impeller even with the minimum working level in the receiver. A drip pocket is incorporated in the design of the Unipump for collecting any stuffing box leakage. Receivers are shaped so that their maximum capacity is utilized, between high and low water levels. Automatic operation is secured through a float switch actuated by ball float on a rigid arm within the receiver. Condensate return pumps are also supplied with the receiver tank beneath the motor with the pump mounted inside the tank. The type of unit is intended for use wherever the return line is below floor level.
SIZES AND CAPACITIES—Nine sizes with receiver capacities ranging from 15 to 60 gal. and for serving systems with square foot of radiator surface between 1500 and 30,000.
MADE BY—*The Weinman Pump Manufacturing Co., 290 Spruce St., Columbus, Ohio.*

Century Single Phase Motor

NAME—Century repulsion start, induction single phase motor.
PURPOSE—To meet the demands of installations where high starting torque, low starting current and automatic starting are desirable.
FEATURES—The manufacturer states that these motors possess the desirable starting characteristics of the repulsion motor and the operating characteristics of the induction motor. During the starting period the motor operates as a repulsion motor with the brushes bearing on the undercut commutator. As the motor approaches full-load speed, the governor automatically short circuits the rotor winding, changing it into an induction motor, and the brushes are removed from contact with the commutator. These motors are self-starting under full load and the manufacturer states that their efficiency is higher than that of any other type of single phase motor. The static torque of the 3 hp., 60 cycle, 1750 r.p.m. and smaller motors is said to be not less than 450% of full load torque while the static torque of larger sizes varies with the horsepower, speed and frequency from 400 to 250% of full load torque. The manufacturer states that any approved switch may be used for starting and stopping the motor and that the fuses which will protect the motor while running and carrying its load are usually of ample capacity for starting due to the low starting current and quick acceleration.
SIZES & CAPACITIES—12 sizes with capacities ranging from ⅛ to 7½ hp.
MADE BY—*Century Electric Company, 1806 Pine St., St. Louis, Mo.*



Starting characteristics of repulsion motor and operating characteristics of induction motor.



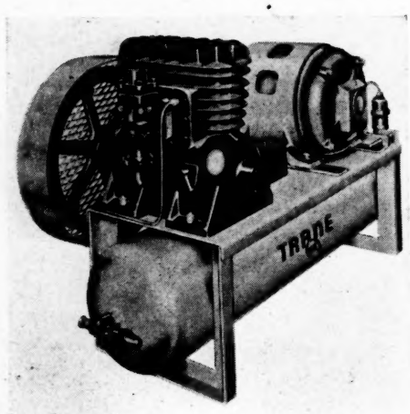
For checking superheat.

Fedders Superheat Thermometer

NAME — Clip-on superheat thermometer.
PURPOSE—For checking superheat of direct expansion air conditioning coils at suction end of each circuit.
FEATURES—Thermometer is said to make it possible to accurately check superheat of direct expansion air conditioning coils at suction end of each circuit of coil and is intended for use in the setting of Fedders individual flow-control valves. It is also possible to check the temperature of the high pressure liquid entering the expansion valve. Inlet and outlet water circulating through air conditioning coils can also be checked.
LITERATURE AVAILABLE—Bulletin 392-A.
MADE BY — *Fedders Manufacturing Co., Buffalo, N. Y.*

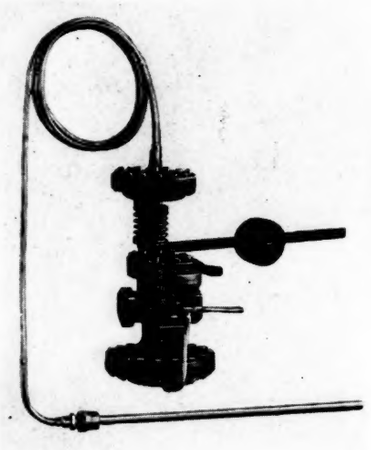
Trane Reciprocating Compressors

NAME—Trane reciprocating compressors.
PURPOSE—For supplying the refrigerating needs of air conditioning systems.
FEATURES—This line of compressors has capacities from 3 to 50 tons. The 3-ton unit utilizes 2 cylinders while the 5 to 25 ton uses 3 cylinders, and the 30, 40 and 50 consist of two compressors with 3 cylinders each. Crank case and cylinder body are built in one piece while the housing cover is dowel-located to the body to make the main bearing self-aligning. Compressors are equipped with strainer and oil separator, oil sight glass, and asbestos composition gaskets with Duprene bindings. All compressors are available in 2 models, one with a condenser tank in addition to the compressor, for use in locations where condenser water is available at low cost, and another with compressor mounted on a sturdy base without refrigerant condensing facilities. This unit is adapted for use with a Trane evaporative condenser where water costs are high.
SIZES AND CAPACITIES — From 3 to 50 tons.
MADE BY—*Trane Company, La Crosse, Wis.*



Trane reciprocating compressor with condenser.

Spence Temperature Controlled Pressure Regulator



Spence temperature-controlled pressure regulator.

NAME — Spence Temperature Controlled Pressure Regulator.
PURPOSE—To regulate the pressure delivered to a heating unit and to shut off when a desired temperature is reached.
FEATURES — The advantages of the type of construction used in this valve are the low-cost, simplified construction, and the complete elimination of stuffing boxes. The illustration shows the Type-W weight loaded pilot designed for delivery pressures less than 10 lb. The unit can also be furnished with the Type-D spring-loaded pilot for higher pressures and can be operated by any type of thermostatic motor including an electric heat motor or a standard two-position electric motor.
MADE BY—*Spence Engineering Company, Inc., Walden, N. Y.*

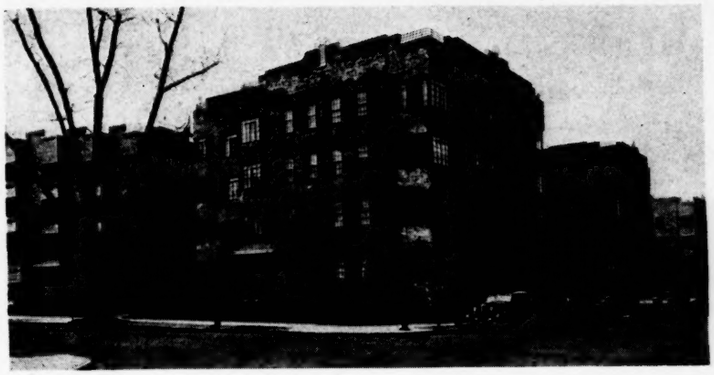
Controls the flow of liquids and gases.

Square D Solenoid Valve

NAME AND MODEL NO. — Solenoid valves, models 9150 A1 and 9150 B1.
PURPOSE—For controlling the flow of liquid and gaseous Freon, methyl chloride, sulphur dioxide, as well as water, oil, and air.
FEATURES—Types A1 and B1 are identical in appearance except that the A1 has a blue style cover and the B1 has a grey enamel cover. The A1 is said to be a quality device with the armature made of high grade stainless steel. In the operation of the valve a maximum lift with a minimum power is said to be obtained by means of the impact with a needle head. A shading coil is provided to assure the sealing of the armature with a flat surface above it so as to eliminate noise and vibration. Needle is made of a stainless metal designed to give long life and tight closing. Valve seat is also of a non-stainless, magnetic metal somewhat softer than the needle to insure closing. Valve B1 is a low priced valve and employs a floating plunger of an impact type.
SIZES AND CAPACITIES — A1 is equipped with three orifice sizes 7/32, 5/32 and 3/32 in. while B1 is equipped with two orifice sizes—3/16 and ⅛ in.
MADE BY—*Square D Company, Regulator Div., 6060 Rivard St., Detroit, Mich.*

Spraying System Nozzle

NAME—Pneumatic atomizing nozzle.
PURPOSE—For humidifying in industrial processes where a constant proportion is to be maintained for intermittent spraying.
FEATURES—Nozzle is available with internally mixed round or flat spray. It is screwed directly into a pipe where liquid is maintained at a constant level (this same pipe serves as air supply header). Standard stock construction is brass; other metals can be specified.
MADE BY — *Spraying Systems Co., 4021 W. Lake St., Chicago, Ill.*



HEAT CONDITIONING FOR COMFORT

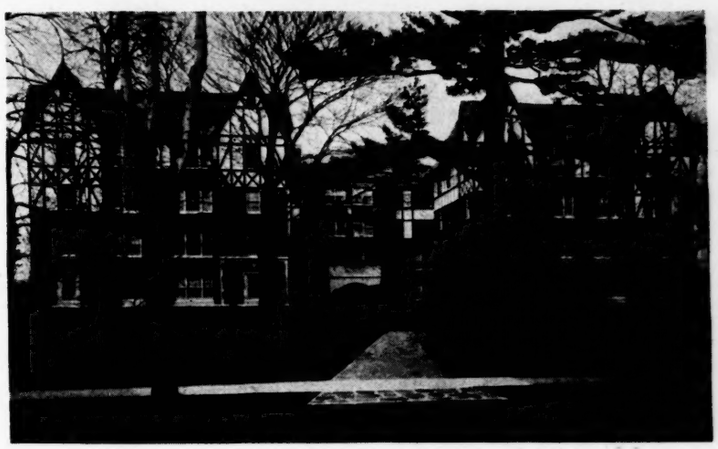
in these

Modern Apartments

ILLINOIS SELECTIVE PRESSURE CONTROL SYSTEMS

Type "C" Combustion Control

(Protected by patents and patents pending)

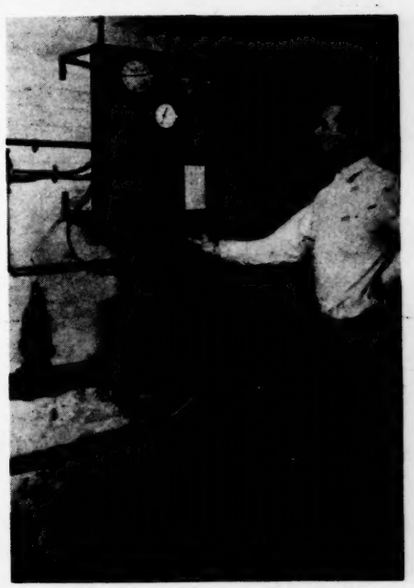


INSURE

- maximum operating economies
- the ultimate in simplicity
- minimum maintenance
- highest boiler and over all plant efficiency
- lowest stack temperature
- controlled domestic hot water supply providing remarkable economies and minimum repair expense

REQUIRE

- no orifices or other retarders
- no complicated electrical or mechanical equipment
- no expert supervision or adjustment



The ILLINOIS SELECTIVE PRESSURE CONTROLLER —the heart of the system—makes possible all of these advantages and permits the automatic operation of the heating system on average radiator temperatures from 110 degrees up to any temperature required.

Write for Bulletin 16

ILLINOIS ENGINEERING COMPANY
2047 SOUTH RACINE AVENUE, CHICAGO

Degree-Day Figures for December, 1939

HEATING & VENTILATING continues its twelfth year of publishing degree-day data for various large cities

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for December, 1939	1176	577	749	504	981	1014	1294
Degree-days, Sept. 1, '39 to Dec. 31, '39	2736	1105	1520	989	2149	2368	3059
Degree-days, Sept. 1, '38 to Dec. 31, '38	2486	1077	1465	984	1932	2243	2785
Degree-days, Sept. 1 to Dec. 31, Normal	2439	1131	1664	913	2130	2372	2773

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for December, 1939	929	930	855	903	904	747	963
Degree-days, Sept. 1, '39 to Dec. 31, '39	2426	2008	1785	1977	1900	1768	2077
Degree-days, Sept. 1, '38 to Dec. 31, '38	2798	2084	1705	1914	1841	2146	2168
Degree-days, Sept. 1 to Dec. 31, Normal	2889	2225	1784	2185	2020	2276	2370

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for December, 1939	980	792	1192	484	922	814	990
Degree-days, Sept. 1, '39 to Dec. 31, '39	2275	1644	3017	960	2106	1590	2175
Degree-days, Sept. 1, '38 to Dec. 31, '38	2213	1752	3377	1001	2017	1485	2094
Degree-days, Sept. 1 to Dec. 31, Normal	2332	1952	3434	1038	2164	1545	2211

	Fort Worth, Tex.	Grand Rapids, Mich.	Green Bay, Wis.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Ithaca, N. Y.
Degree-days for December, 1939	385	964	1059	903	1012	898	1076
Degree-days, Sept. 1, '39 to Dec. 31, '39	751	2214	2546	1924	2255	1862	2491
Degree-days, Sept. 1, '38 to Dec. 31, '38	888	2149	2618	1915	2038	1819	2387
Degree-days, Sept. 1 to Dec. 31, Normal	826	2397	2882	1981	2157	2002	2450

	Kansas City, Mo.	Knoxville, Tenn.	La Crosse, Wis.	Lansing, Mich.	Lincoln, Neb.	Little Rock, Ark.	Los Angeles, Calif.
Degree-days for December, 1939	795	701	1070	1028	901	556	80
Degree-days, Sept. 1, '39 to Dec. 31, '39	1657	1370	2443	2456	1907	1121	118
Degree-days, Sept. 1, '38 to Dec. 31, '38	1673	1372	2580	2405	1961	1123	262
Degree-days, Sept. 1 to Dec. 31, Normal	1809	1483	2778	2665	2201	1079	424

	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.
Degree-days for December, 1939	822	1029	572	967	1154	661	952
Degree-days, Sept. 1, '39 to Dec. 31, '39	1630	2332	1146	2166	2665	1344	2110
Degree-days, Sept. 1, '38 to Dec. 31, '38	1546	2513	1122	2303	2831	1315	1896
Degree-days, Sept. 1 to Dec. 31, Normal	1587	2758	1127	2601	2941	1363	2109

	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.
Degree-days for December, 1939	221	887	640	578	953	965	836
Degree-days, Sept. 1, '39 to Dec. 31, '39	406	1858	1213	1142	2033	2034	1717
Degree-days, Sept. 1, '38 to Dec. 31, '38	492	1659	1085	1305	2079	2040	1586
Degree-days, Sept. 1 to Dec. 31, Normal	403	1849	1195	1379	2284	2323	1735

	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.	Reno, Nev.	Richmond, Va.
Degree-days for December, 1939	864	1116	580	963	882	737	737
Degree-days, Sept. 1, '39 to Dec. 31, '39	1862	2594	1356	2154	1881	1733	1504
Degree-days, Sept. 1, '38 to Dec. 31, '38	1827	2315	1525	1908	1811	2185	1385
Degree-days, Sept. 1 to Dec. 31, Normal	1949	2496	1724	2130	2014	2284	1407

	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.	Spokane, Wash.
Degree-days for December, 1939	1031	795	806	300	1033	544	868
Degree-days, Sept. 1, '39 to Dec. 31, '39	2377	1581	1785	673	2353	1429	2229
Degree-days, Sept. 1, '38 to Dec. 31, '38	2225	1551	2152	848	2178	1613	2382
Degree-days, Sept. 1 to Dec. 31, Normal	2414	1738	2149	949	2274	1881	2583

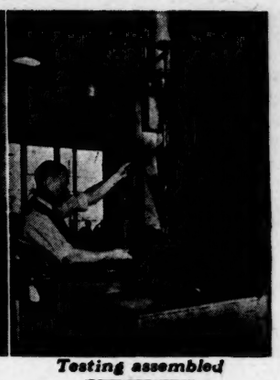
	Springfield, Ill.	Syracuse, N. Y.	Toledo Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for December, 1939	890	1076	961	899	1224	772	742
Degree-days, Sept. 1, '39 to Dec. 31, '39	1808	2459	2127	1932	2677	1612	1496
Degree-days, Sept. 1, '38 to Dec. 31, '38	1804	2254	2095	1785	2531	1557	1598
Degree-days, Sept. 1 to Dec. 31, Normal	2002	2491	2189	1760	2537	1741	1783

Methods of applying the degree-day in connection with the operation of heating plants or for the prediction of fuel consumption of heating plants are described fully in the new enlarged edition of the DEGREE-DAY HANDBOOK, published by HEATING & VENTILATING, 148 Lafayette Street, New York, price $3. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

Tests that assure the dependable, trouble-free performance of

CURTIS Condensing Units

Testing castings for leaks



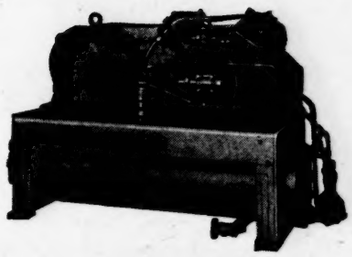
Testing assembled compressors

Inspecting for Leaks— in castings—in assembled compressors

● Every Curtis casting is carefully checked for possible leaks **before** it is incorporated in the Curtis unit. Castings are put under air pressure and tested under water. Because Curtis operates its own foundry, no attempt is ever made to plug casting leaks, or to seal them by galvanizing and other methods. Such castings are rejected and melted down.

In addition, the compressors completely assembled, are again pressure tested under water as a final check for any possible leaks that might have developed during machining, finishing and assembling.

Tests such as these are only two of many examples of the care and precision of Curtis manufacturing methods. All contribute to the high efficiency, trouble-free performance and exceptionally long life of every Curtis Condensing Unit.



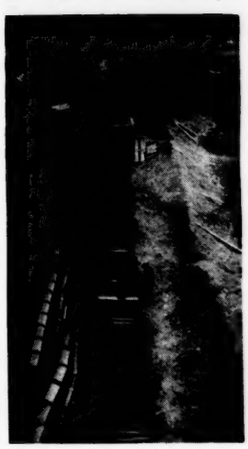
Curtis 15 H.P. Shell and Tube Condensing Unit. Also sizes up to 30 H.P.

Curtis Refrigerating Machine Company
1999 Kienlen Avenue, St. Louis, Missouri

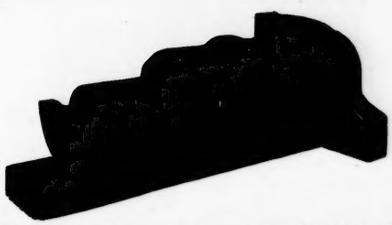
CURTIS REFRIGERATION AIR CONDITIONING and COMMERCIAL

Division of Curtis Manufacturing Company

ADSCO-BANNON CONDUIT
TILE CONDUIT FOR UNDERGROUND LINES



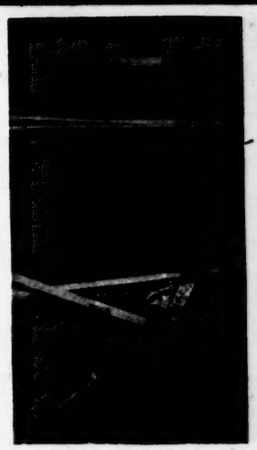
Partial view of steam and return lines in separate conduits serving a Federal Housing Project.



Over 3,500 Feet Used by Municipal Utility* for Steam Line to Federal Housing Project

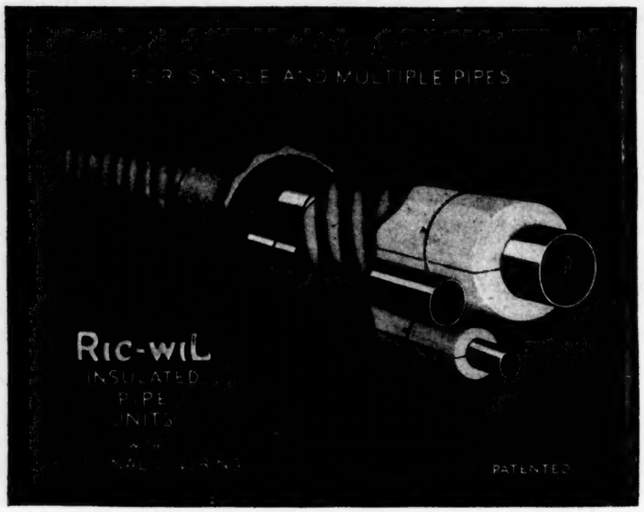
A complete ADSCO installation—ADSCO-Bannon Tile Conduit, ADSCO-Fiberglas Filler Insulation and ADSCO Piston-Ring Expansion Joints—an excellent combination for economy, thermal efficiency and years of satisfactory service.

ADSCO-Bannon Tile Conduit is strong, vitrified tile conduit, easily separable on the job to accommodate one or more bare or insulated pipes. The pipe supports fit in recesses in the support sections of conduit and do not pierce the conduit wall, thus eliminating a source of water seepage. (* Name upon request)



View of manhole showing tile conduit and ADSCO Piston-Ring Expansion Joints used at a Federal Housing Project.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS



U. S. Patents 1,991,455 and 2,050,968. Canadian Patent 360,816. Other Patents Pending

RIC-WIL Insulated PIPE UNITS

PRE-SEALED UNITS for underground steam lines, in standard pipe lengths, complete with steam pipes and all accessories.

ARMCO HEL-COR CONDUIT of heavy gauge pure ingot iron, heavily galvanized, with protective asphalt coating and asbestos-asphalt felt wrapping to resist all forms of deterioration.

WATER-TIGHT, light in weight, yet amply strong to stand abnormal stress and strain, even in shallow trenches.

PIPE SUPPORT GUIDES (semi-steel rings carried in special cement insulation) are threaded into each end of the Hel-Cor Conduit, to give permanent pipe alignment, and seal ends of units. These supports are locked securely in place but may be unscrewed.

INSULATION — any standard material in recommended thickness may be specified, such as 85% magnesia or laminated asbestos spongefelt sectional coverings. Asbestos fibre, hand moulded insulation with roofing jacket, can also be furnished.

CLOSURE BETWEEN UNITS is made by wrapping heavy asbestos-asphalt felt over the opening between the units, the felt cemented and wired in place. Connector Sleeve, made from heavy gauge Armco Asbestos Bonded Ingot Iron, previously placed over the Hel-Cor before welding the steam pipe, is slipped over the felt and the annular space at each end is hermetically sealed with high melting point non-porous mastic cement and wrapped with tape furnished. Connections are positive and subject to complete inspection at all times. **NO GUESSWORK INVOLVED.**

Complete descriptive bulletin on request.

The RIC-WIL Co., Union Commerce Bldg., Cleveland, Ohio
New York **San Francisco** **Chicago**
Agents in principal cities

REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

COMING EVENTS

MARCH 18-21. Ninth Annual Forced Warm Air Conference sponsored by the National Warm Air Heating and Air Conditioning Association. To be held at Michigan State College, East Lansing, Mich. Further information obtainable from Prof. L. G. Miller, Michigan State College, East Lansing, Mich.

APRIL 9-10. Annual Midwest Power Conference; Palmer House, Chicago, under direction of Prof. S. E. Winston, 401 S. Quincy St., Hinsdale, Ill.

MAY 14-17. Annual meeting of the National District Heating Association; French Lick Springs Hotel, French Lick, Indiana. Further information available from John F. Collins, Jr., Secretary-Treasurer National District Heating Association, 1231 Grant Building, Philadelphia, Pa.

MAY 21-24. 34th annual convention of the Smoke Convention Association at Hotel Statler, St. Louis.

JUNE 6-7. Annual meeting of the Stoker Manufacturers Association at the Homestead Hotel, Hot Springs, Va.

H&V'S PHOTOS

Page 15—Howard Earl Day, St. Louis, Mo., for Carl Boester.
Page 25—Hedrich-Blessing Studio, Chicago, for Albert Kahn, Inc., Detroit.
Page 26-32—Albert Kahn, Inc., Detroit.
Page 39—The Austin Company, Cleveland.
Page 40—(Upper right) Grignon, Chicago, for The Austin Company, Cleveland.
Page 41—The Austin Company, Cleveland.
Page 42—George H. Watson, Birmingham, Ala.
Page 43—Map by Rand McNally & Company.
Page 44-48—Joseph F. Kern, Jr., Assistant Editor.
Page 49—Map by The Montcastle Map Co.
Page 50-58—Clifford Strock, Associate Editor.

WITH THE MANUFACTURERS

Allen-Bradley Co., Milwaukee, has appointed *L. M. Perkins* manager of the air conditioning and refrigeration control division. Mr. Perkins, who was formerly with the Carrier Corporation, will be in charge of product development and sales promotion.

American Machine and Metals, Inc., East Moline, Ill., has appointed *George Koch Sons, Inc.*, as exclusive agents in Evansville, Indiana, for its line of DeBothezat ventilating equipment.

Automatic Gas-Steam Radiator Company, Pittsburgh, Pa., has changed its name to the Automatic Gas Equipment Company, due to the broadening of the company's line of products.

The Brundage Company, Kalamazoo, Mich., has moved to its new address, 512 North Park Street, Kalamazoo.

Centrifix Corp., Cleveland, has appointed *Sawyer-Massey, Ltd.*, Hamilton, Ontario, as its exclusive Canadian manufacturers.

Conco Sampsel Stoker Corporation, Mendota, Ill.. has changed its name to *Conco Corporation* in order to more appropriately represent its activities since it has introduced its new line of gas-fired heating and air conditioning equipment.

Electric Furnace Man, Inc., New York, announces that *Oscar F. Ostby* has returned to the company as

vice-president in charge of sales, from which position he resigned in 1936 to become associated with the anthracite industry. Mr. Ostby will be located in the company's sales office at 101 Park Ave., New York.

The Emerson Electric Mfg. Co., St. Louis, Mo., has elected *Oscar C. Schmitt*, executive vice-president and has promoted *Raymond E. Otto* to manager of sales. *W. R. Fraser*, New York district manager, has been promoted to manager of motor sales in St. Louis. Mr. Schmitt was formerly vice-president in charge of sales and Mr. Otto was formerly manager of motor sales.

General Electric Co., air conditioning and commercial refrigeration department, Bloomfield, N. J., has appointed *Elliott Harrington* and *H. T. Hulett* as western and eastern sales manager, respectively. Both will maintain headquarters in Bloomfield. Under these dual managers will be four zone managers, two for each half of the country.

The Lau Blower Co., Dayton, Ohio, has appointed *Fritz Lautz* as sales engineer in Michigan, Indiana, northern Ohio and parts of Canada.

Mayflower Air Conditioners, Inc., St. Paul, has appointed *H. M. McGaughey* as vice-president. Mr. McGaughey was with the Kelvinator Division of Nash-Kelvinator Corporation for the past 10 years.

National Radiator Company, Johnstown, Pa., has appointed *Ellis L. Redden* as advertising and sales promotion manager. Mr. Redden was formerly with the Delco-Heat Division of General Motors, with which organization he was factory district manager and assistant advertising and sales promotion manager.

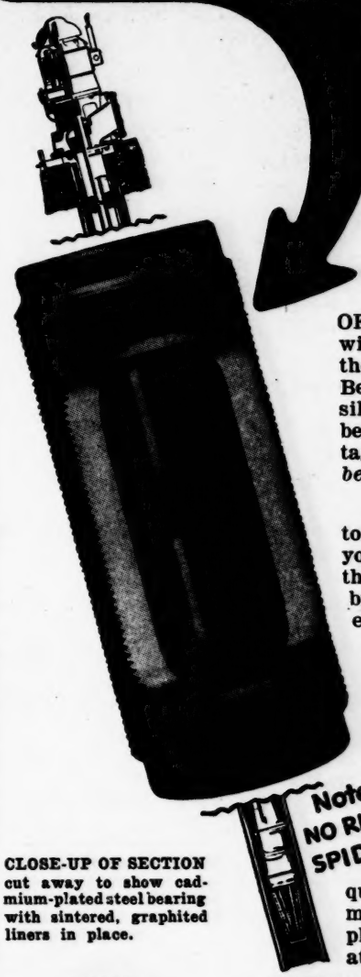
The National Radiator Co., Johnstown, Pa., has acquired the business and assets of the *Century Specialty Company* of Johnstown. The business will be operated as a division of The National Radiator Company. It will continue to make pressed metal jackets for small and large boilers. *James F. Thomas*, formerly president of the Century Specialty Company, is manager of the division.

Perfex Corp., Milwaukee, announces that *L. B. (Pat) Miller* has joined its automatic control division in a sales executive capacity. Mr. Miller is one of the pioneers of the control industry. With E. N. McDonnell, he founded the firm of McDonnell & Miller, manufacturers of low water cut-offs, in 1924. He sold his interest to Mr. McDonnell in 1929, and joined the Time-O-Stat Controls Company as assistant sales manager. This company was purchased by Minneapolis-Honeywell in 1931, and he took charge of the refrigeration control division of that concern. In 1932 he initiated the activity of Minneapolis-Honeywell in the air conditioning field, and for the next five years was prominently identified in this phase of the control business. He then introduced the Polatron system of control, and managed this activity until his resignation.

L. B. (Pat) Miller

Joseph T. Ryerson & Son, Inc., Chicago, has been named distributors of McKay certified stainless steel electrodes. They will be stocked by all Ryerson branches.

NEW IMPROVED DRIVE SHAFT BEARING



MAKES STERLING DEEP WELL PUMPS

More Trouble-Free Than Ever!

OF cadmium-plated steel shells, with sintered, graphited liners, these new Sterling Drive Shaft Bearings retain the full tensile strength of the all-bronze bearing plus the added advantage of being lined with the *best possible bearing material.*

And because it is now "steel to steel" in Sterling Pumps, you no longer need to fear the galvanic action between bronze and steel at shaft-enclosing tube joints.

Extra security against scored bearings is another advantage, because the graphited material will run for many hours *without any other lubrication!*

Think of these advantages. Surely they will lead you to ask questions. For further information write, wire or telephone "Pump Headquarters" at once!

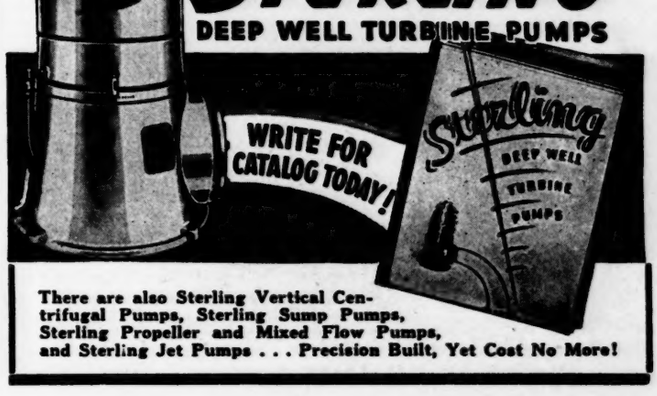
Note: NO RIGID SPIDERS

CLOSE-UP OF SECTION cut away to show cadmium-plated steel bearing with sintered, graphited liners in place.

STERLING PUMP CORP.,
HAMILTON, O., STOCKTON, CAL.
Service (if you need it) From Coast to Coast

PRECISION BUILT

STERLING
DEEP WELL TURBINE PUMPS



There are also Sterling Vertical Centrifugal Pumps, Sterling Sump Pumps, Sterling Propeller and Mixed Flow Pumps, and Sterling Jet Pumps . . . Precision Built, Yet Cost No More!

Philco Radio & Television Corp., Philadelphia, Pa., has placed *Harry Brown*, national merchandising manager, in charge of all Philco air-conditioning activities.

Sheffler-Gross Co., Inc., Philadelphia, has added *George F. Bertrand* to its staff as sales engineer. Mr. Bertrand has had 15 years experience in the air conditioning field and will specialize in the sale of air conditioning devices sold by this company.

Unit Heater & Cooler Company, Wausau, Wisconsin, has been taken over by *D. J. Murray Mfg. Company*, the parent company. The new arrangement is expected to result in more concentrated and extensive efforts on behalf of the company's line of heating and cooling products.

Wheelco Instruments Co., Chicago, has appointed Rodgers Engineering Company, 204 Thomas Building, Dallas, Texas, as its representative for the North Texas territory with Dallas as headquarters.

Stewart E. Lauer

York Ice Machinery Corporation, York, Pa., has elected *William S. Shipley*, for the past ten years president of the company, chairman of the board of directors. *Stewart E. Lauer*, formerly vice-president, was elected president; *E. A. Kleinschmidt*, executive vice-president and *Llewellyn Williams*, vice-president in charge of engineering. Mr. Lauer, the new president, has been vice-president in charge of sales for several years.

Young Radiator Company, Racine, Wisconsin, has appointed *Ameresco Incorporated*, 50 Church St., New York, as export distributors for Young products.

NEW TRADE LITERATURE

Convectors. A 4-page standard size bulletin No. H-240, illustrating and describing the Kramer line of copper convectors. Includes information on capacities and sizes. KRAMER TRENTON COMPANY, TRENTON, N. J.

Refrigeration. Standard size 8-page bulletin W-207-B1 on Worthington steam-jet vacuum refrigeration units. Gives information on typical applications, cycle of operation, details of construction, specifications and capacity ratings. Also includes a chart of engineering data for estimating purposes. WORTHINGTON PUMP AND MACHINERY CORPORATION, HARRISON, N. J.

Spray Nozzles. A standard size 22-page catalog on the Monarch line of oil burner accessories, including oil atomizing nozzles, fuel oil pumps and pumping units, strainers, stabilizers, and regulating and cut-off valves. Also includes information on spray nozzles for many applications, such as air conditioning sprays, recooling sprays and milk powdering. MONARCH MFG. WORKS, INC., SALMON AND WESTMORELAND STREETS, PHILADELPHIA, PA.

Unit Heater. A 12-page standard size bulletin U-4C on Wing unit heaters for general purpose heating. Provides piping and wiring details and pertinent engineering data on the new model Wing utility unit heaters. Also gives some information on other Wing products. L. J. WING MFG. CO., 154 W. 14TH ST., NEW YORK, N. Y.

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